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On Feb. 20 Jersey City will for the second time receive bids for a new water supply. Bidders must state the price per million gallons for which water will be delivered by gravity into the present receiving reservoir at Belleville, and the additional price for water delivered by gravity into the high service reservoir on Bergen Hill. The minimum daily supply must be 22,000,000 gallons, and the maximum 50,000,000 gallons, with a 35,000,000-gallon delivery capacity pipe line at the start, and reservoirs capable of storing, on the basis of the minimum annual rainfall since 1880, a 100 days' supply, of which a 60 days' supply must always be in storage. Either cast iron or steel pipes may be used for the conduits. The water must be collected within the state of New Jersey. The city reserves the option to buy the works at any time within ten years after the first delivery of water. The Board of Street and Water Commissioners of Jersey City, N. J., will give further information. The conditions upon which bids were asked last fall were given in our issue of Oct. 27, 1892, and the results of the invitation for proposals were given in our issue for Nov. 24, 1892. But one formal bid, from Moffett, Hodgkins & Clarke, New York, was received, and that has since been rejected.

The New York & New Jersey Bridge Bill, which was introduced last March into the Senate, at Washington, by Mr. Blackburn, on behalf of G. W. Green and C. Swan, and which was referred to the Senate Committee on Commerce, was returned to the Senate with an adverse report by the committee. A motion to take up the bill was made on Tuesday, but was not successful, and it is not considered probable that the Senate will overrule the adverse report of the committee.

The absorption of the Old Colony R. R. by the New York, New Haven & Hartford R. R. Co. is informally announced by Pres. Chas. F. Choate, of the former company, although the terms of the consolidation have not been definitely decided upon, or ratified by the stockholders. By the negotiation the New York, New Haven & Hartford R. R., which controls 834 miles of railway, will add 619 miles of line to its system, making its total mileage 1,453 miles. The new system comprises some of the most valuable railway properties in the United States in the points of traffic and earnings, and controls access to the most valuable terminals in New York and Boston, and many of the larger cities in Connecticut, Rhode Island and Massachusetts. The gross earnings of the various lines for their last fiscal years aggregate $21,610,225, or almost exactly one-half the total gross earnings ($43,501,287) of the Atchison, Topeka & Santa Fe system, with a mileage of 9,327 miles. The dividends of the New York, New Haven & Hartford R. R., proper, have been regularly 10% per annum since 1872, and those of the Old Colony 6½% per annum from 1882 to 1891 inclusive, and since, 7% per annum. The market price of the stock of the former company ranged from 224 to 279 from 1889 to 1893, inclusive, and the present market price of the stock of the latter company is 221.

The new steamship "Lucania," of the Cunard line, was launched at Glasgow on Feb. 2. She is 625 ft. long over all, 65 ft. beam, and 41 ft. deep. Her measurement is nearly 13,000 tons. The "Lucania" is about 20 ft. longer and 7 ft. broader than the "Teutonic" or "Majestic," of the White Star line.

The Minnesota State Road Improvement Association has been organized as a result of the late Road Congress at St. Paul, Minn. The President is Mr. A. B. Choate; the Secretary is Mr. F. L. Hoxie, of St. Paul, and a Vice-President was elected for each county in addition to a Board of Directors.

Two two-cylinder compound locomotives of the consolidation type have been built by the Rhode Island Locomotive Works, Providence, R. I., for the Minneapolis, St. Paul & Sault Ste. Marie Ry. The engine has a swing-center truck, and the valve motion is of the shifting-link type. The feed is supplied by two injectors. The driving wheels have Midvale steel tires, 3 ins. thick, with wheel centers 44 ins. diameter. The general dimensions of the engines are as follows:

Driving wheels, 8, diam.	4 ft. 2 ins.
Wheel base, driving	15 " 0 "
" " of engine	22 " 6 "
" " of engine and tender	49 " 10¾ "
Weight, on drivers	120,000 lbs.
" on truck	11,000 "
" total engine	131,000 "
" of tender	75,000 "
" engine and tender	206,000 "
Cylinders, h. p.	21 × 24 ins.
Cylinders, l. p.	31 × 24 "
Boiler, wagon top, steel.	
" diam. of barrel at smokebox end	5 ft. 2 ins.
" thickness of barrel plates	9-16 "
Dome, diam.	2 ft. 6 ins.
Working pressure	160 lbs.
Firebox; steel	9 ft. × 2 ft. 10 ins.
Water space, 3½ ins. at sides and back; 3½ to 4 ins. at front.	
Tubes, iron; number	246
" diameter, 2 ins.; length	13 ft. 8 ins.
Capacity of tank	4,000 galls.

A tire of the front driving wheel of a locomotive on the New York & Greenwood Lake R. R. broke Feb. 3, while the engine was running on a down grade, near Arlington, N. J., with a suburban passenger train. A piece about 14 ins. long was broken out of the tire and the remainder soon left the wheel without injuring main or parallel rods. Aside from stripping off the sand pipe, smashing the footboard and knocking a hole in the tank, no damage was done to the locomotive, and neither the wheel which lost its tire nor any other in the train, left the track. The train ran some 1,500 ft. after the tire left the wheel before stopping. The broken tire showed a minimum thickness of 1½ ins., and had evidently been recently turned down to 1⅝ ins. While this is a thinner tire than is permitted by some roads, there are others which defend the use of tires even thinner than this. No flaw was discernible at the fracture; but the break was very smooth and square, and showed a somewhat crystalline structure.

The most serious railway accident of the week was a rear collision on the Baltimore & Ohio R. R., Feb. 6, at Williams, Pa. A freight train became unmanageable on the heavy grade, owing to ice on the rails, and the train ran into another freight train. Two men were killed, and several injured, one fatally.

A trestle near Jackson, Miss., on the Illinois Central R. R., gave way under a freight train Jan. 26, and five cars were thrown into the creek.

A locomotive boiler explosion occurred at Fort Scott, Kan., on the Missouri Pacific Ry., Jan. 31. The engine was standing in the shop yards, after having hauled a passenger train from Kansas City, and a machinist was investigating the pop safety valve; the engineman having reported it defective. The machinist was fatally injured, and the engineman badly hurt.

The roundhouse, machine shop and repair shop of the Pittsburg & Western R. R., at Allegheny, Pa., were burned last week. Six engines under steam in the roundhouse were run out and little damaged, but six engines in the repair shop were much damaged. The loss is estimated at $25,000.

The speed recorder, invented by Mr. Wm. D. Weaver, Asst. Engineer U. S. N., and used in recording the speed at the trial of the parctice cruiser "Bancroft," measures the time and the number of revolutions. Five marking pens are used, registering on a band of paper; two of the pens are electrically connected with the port and starboard shafts, respectively; the third is connected with a chronometer, and the two remaining with the range keys. Each full revolution of the shaft is marked, as is also the end of each second; and upon entering and leaving the range course the two marginal pens make datum marks, which determine the limits between which the time and revolutions are to be counted. The instrument is designed to stand hard usage. It was used at the launch of the "Texas" to determine the speed of passage down the ways.

Cable and electric cars in Pittsburg have rights which the citizens must respect, says Judge McCollum, of the Supreme Court of Pennsylvania, in a suit for damages caused by an electric car running down a team unloading before a business house. Judge McCollum says that the conditions have changed since the days of omnibus and horse cars, and that rapid transit is now recognized and demanded as essential to the prosperity of and the transaction of business in large cities; and the use of streets for individual convenience is necessarily qualified, so as to make that transit possible and to minimize its dangers. The substitution of cable and electric cars for horse cars and omnibuses, renders impracticable and dangerous certain uses of the streets which were once permissible and comparatively safe. The non-observance of these new conditions constitutes negligence, says Judge McCollum.

The tests of the pneumatic guns of the dynamite cruiser "Vesuvius," at Port Royal, S. C., have so far been satisfactory; though at this writing the trial with loaded shells has not yet taken place. At 1,000 and 2,000-yd. ranges the shots were remarkably accurate, two consecutive phenomenal shots at 2,000 yds. falling exactly on the same spot. At 500 yds. the practice was not quite so good, requiring further adjustment of the air valves for that distance. The flight of the shells is being photographed by Ensign Ackerman, and it is now well established that the shots after failing to the water surface assume a horizontal position, and push forward for a hundred yards or more toward the target. Heavy fogs have delayed the tests for some days.

A bill to dam the Brazos River, at Waco, Tex., has been favorably reported by the Texas Legislature. The power is also granted to the Waco Water Power & Electric Co. to maintain a dam of not less than 15 ft. at any point within 5 miles of the suspension bridge at Waco.

The deepest artesian well in the world is said to be one of 4,194 ft., near Berlin, which penetrates a solid bed of salt for most of this distance. The St. Louis, Mo., well is the next deepest, with 3,843½ ft., and the third is a well 3,553 ft. deep, at Titusville, Pa.

The present exorbitant charges for street lighting form the subject of a special message issued by the mayor of Boston, Mr. N. Matthews, Jr. He petitions the Massachusetts Legislature to enact certain laws permitting Boston to manufacture or purchase gas and electric light for the streets, etc., of that city at fair and reasonable prices, and points out the methods proper for attaining this end. The city has had the right, until 1891, to establish a plant to light the streets at public cost, but the municipal lighting bill of that year took away this right; and a repeal of this restriction is now asked for. The mayor says that the cost of manufacture of gas in Boston is 53 cts. in the holder and 77 cts. at the consumers' meter; yet $1.00 to $1.50 is charged by the gas companies for street lamps, and still higher prices are paid by consumers. For electric light of 2,000 c. p. commercial, the city is paying 40 cts. per night. A series of detailed estimates is presented by William Jackson, City Engineer, with this message. The mayor also obtained estimates from the managers of the Massachusetts Electrical Engineering Co., and these two sets of estimates are tabulated and presented as follows:

Estimates for Municipal Street-Lighting Plant.

No. of lamps.	No. of stations.	Cost of plant.	Cost for maintenance, including 6% for interest and sinking fund.	Total cost per lamp, year.	Total cost per lamp, night, cts.
Stone & Webster's estimate.					
2,000	2	$1,437,200.00	$267,499.50	$133.74	36.6
3,000	2	1,549,200.00	320,553.25	106.84	29.2
City Engineer's estimate.					
2,000	1	953,000.00	202,347.50	101.17	27.7
3,000	1	1,286,320.00	283,120.45	94.37	25.8

A railway cut 127 ft. deep and 529 ft. long, through solid limestone, was made by the Pennsylvania R. R. in straightening its main line at No. 5 bridge over the Juniata River, in Pennsylvania. This cut is 56 ft. wide at the bottom and 160 ft. at the top, and contained 120,000 cu. yds. of rock. The fact that it was built for four tracks explains why the hill was not tunneled. During the operation of removing this material a dynamite blast lifted a 60-ton mass of rock and threw it onto the old iron bridge alongside, completely demolishing one span, and suspending traffic for some time. A stone bridge of four 35-ft. arches now replaces the former iron bridge. The engineer in charge was Mr. Frank Brown, Assistant Supervisor Monongahela Division, Pennsylvania R. R.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 52.)

Atlantic City, N. J.

The sewage purification works at Atlantic City are of unusual interest because a record is kept of the actual amount of sewage disposed of each day, all the sewage being pumped. The daily pumping records for a year have been obtained through the kindness of the superintendent of the system, Mr. A. M. Jordan, and are presented below, with the aid of diagrams and tables. The works are also of interest because of some details of the construction of the sewerage system, which have been given space here as worthy of record, although only indirectly connected with sewage purification.

The system of purification in use at Atlantic City consists of an elevated filter bed, in which sand with hay below is used as a filtering material, and from which the effluent falls in small streams or in drops some 3 ft. to gathering gutters which lead to an effluent pipe. It is claimed for this system that filtration is supplemented by aeration, and thus that greater purification is secured. The rate of filtration at Atlantic City is so rapid, as stated in detail below, that only partial mechanical filtration, or straining, can be expected, and this is all that is claimed for the plant, by its superintendent, at least.

Atlantic City is a well known seaside resort which has many visitors in the winter, but a much larger number in the summer. Its population in June, 1890, was 13,055, against 5,477 in 1880. It is said that during the height of the summer season as many as 150,000 people are to be found in the city on some Sundays.

Water-works were built in 1883 by the Atlantic City Water-Works Co., and in 1888-9 the Consumers' Water Co. built works. The city bought the works of the Consumers' Water Co. in the latter part of 1892, and the council has voted to buy those of the other company.

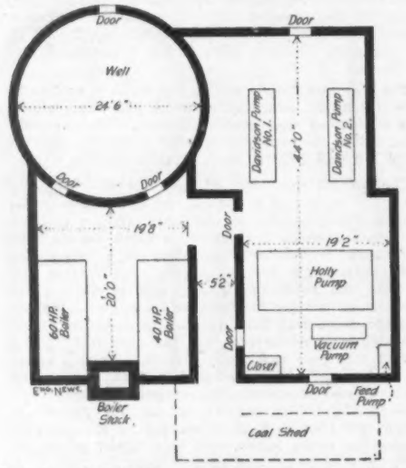


Fig. 59. Sketch Plan of Sewage Pumping Station at Atlantic City, N. J.

In November, 1884, the city granted a franchise for a system of sewers to the Improved Sewerage & Sewage Utilization Co. The system was built in 1885, with Robinson & Wallace, 129 East Twenty-third St., New York, as contractors, and with Mr. A. M. Jordan in charge of construction. Mr. Jordan has since been, and now is, superintendent. The old company went into the hands of a receiver, and was reorganized as the Atlantic City Sewerage Co.

The franchise provided that the sewerage system should be built under the "West Patent," granted to Mr. W. S. West, which covered some details of the pumping system, and also in accordance with designs for filter beds submitted to the City Council by Mr. West, some features of which have since been patented. The National Sewerage & Sewage Utilization Co., of New York, now control the so-called "West System."

There are now about 26 miles of sewers in the city, with which 2,140 connections had been made up to Dec. 1, 1892. Aside from the admission of water from a few roofs, the system is on the separate plan. Most of the roof water is introduced at dead ends for flushing, but about ten houses are connected with the sewers, for which a rental of $2 per 100 sq. ft. per annum is charged.

Owing to the low level of the city all the sewage is conveyed to a well within the pumping station, shown with approximate correctness in the two sketches, Figs. 59 and 60. The pumping station is situated in about the center of the city, on the east and west line, but at the northern limit of the built-up portion, at the edge of the meadows. There are houses and other buildings close by it. A 20-in. cast-iron main conveys the sewage to the pump well.

In laying the sewers sheet piling was necessary, as the water level is only about 3 ft. from the surface in dry, and 1 ft. in wet weather. In sinking the sheet piling for the deepest sewers, 15 to 17 ft. deep, a water jet was used until the water company raised its charge for water from $12 to $15 per day, after which gum-wood mauls were used to sink the sheeting until the charge for water was reduced to $7.50 per day. As good progress was made with the mauls as with the water jet, but the relative cost is not stated.

Cold lead joints were made in connection with the large iron mains, and a putty of tar and cement was used afterwards to stop possible air holes.

In sinking the pump well, sheet piling, 3 ins. wide and 6 ins. thick, was used. As soon as water began to give trouble in the excavation, a pulsometer pump was used, which sometimes threw out 75% of sand. When the proper depth was reached, 20 carpenters were ready with a platform of planking on 6×8-in. timbers, which was lowered to place. The center piece shown in Fig. 60 was then placed, after which the pulsometer, which had been working until this time, was stopped, 3 ft. of concrete laid and water let in to harden the concrete. During the remainder of the work the pulsometer lifted water from a hole dug outside the sheeting. Above the concrete two courses of brick in Portland cement were placed, the first course on edge, the second flat. On top of the brick 3 or 4 ins. of cement mortar, 1 part sand, 2 parts cement, was placed. The sand used for mortar was brought from the mainland. The brick lining wall of the well is 27 ins. thick, including a 3-in. space to above the water line filled with coal tar, asphalt and sand, put in hot, enough asphalt being used to cause the mixture to harden. The wall was laid in Portland cement.

The pump well is 24½ ft. in diameter, and about 20 ft. deep, but only a part of the well is used for sewage, the pumps originally having been placed on a gallery floor in the well, shown in the section, Fig. 60.

As the sewage enters the pump well it passes through a screen of ½ or ¾-in. gas pipe, placed about 1½ ins. apart. In summer, it is stated, some three bushels of rags and other matter are retained by the screen, daily. A ventilation pipe extends from the pump well, above the sewage line, to an outer flue around the smoke flue of the boiler chimney. On descending to the floor in the pump well the writer found only a very slight odor, nor was there anything offensive in or about the pumping station.

As has been stated, the pumps were first located in the well, which, with the boiler room, constituted the station. For about two years the sewage was pumped with the pulsometer, but of course this proved to be too expensive, and for this temporary plant two Davidson pumps, each with a capacity of about 1,000,000 gallons, were substituted. Some two years or more ago a 7,000,000-gallon Holly pumping engine was added. The present location of the pumps and the 40 and 60-HP. boilers is shown by the sketch, Fig. 59. The addition of an 80-HP. boiler has been spoken of, for use in connection with the Holly pump.

A 16-in. cast-iron force main extends from the pumping station across the meadows to the filter beds, a distance of 3,200 ft. The force main was originally about 1,100 ft. long, ending in a filter bed nearer the city, and about half the size of the present bed. The filter beds are about 25 ft. above the bottom of the pump well. Mr. Jordan states that the pump register shows about 15 lbs. pressure when the pumps are run at moderate speed, and about 30 lbs. when run very fast.

The structure which supported the filtering material of the old filter beds, like the present ones, was of wood, which, after four years of use, became decayed. Meanwhile property owners who wished to sell lots in the adjacent section of the city complained that the beds were too close by their land, so when new and larger beds were built they were located as stated above.

The present filter beds are 30 ft. wide by 130 ft. long, divided into eight sections. A wooden trough, extending through the center of the bed, lengthwise, conveys the sewage to the different sections. The filtering material is supported by 2×10-in. plank on edge, 2 ins. apart, and consists of from 15 to 24 ins. of hay, generally heavy sedge grass, cut near the beds, above which is from 6 to 8 ins. of sand, dredged from the adjacent creek. Boards are laid on top of the sand, apparently with the intention of causing a more even distribution of the sewage over the entire area, the boards being laid a short distance apart, and being perforated with augur holes. The sewage passes from the central channel directly onto each compartment through openings which are closed, when desired, by boards lifting vertically.

The effluent drops some 3 ft. onto a wooden platform, from which gutters convey it to a terra cotta pipe, 30 or 40 ft. long, ending in the creek.

In summer it is stated that the filtering material, both sand and hay, is renewed once in two weeks, four sections per week, and in winter, once in four weeks, two sections per week. The sludge from the surface of the beds is buried beneath sand, close by, and the waste material is used for filling in about the beds.

The writer visited the beds Oct. 27, 1892, early in the morning of a cold October day. About 4 ins. of sludge, the accummulation of a week, was found on one section of the beds.

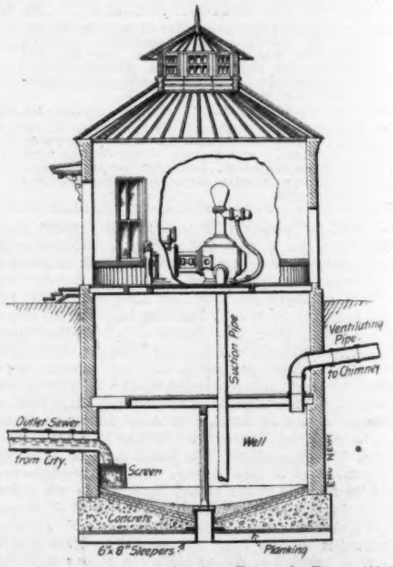


Fig. 60. Approximate Section Through Pump Well.

The creek at the point of discharge of the effluent showed scarcely any sign of pollution, there being only a slight deposit of fine matter on the bank of the creek, which appeared to have come from the beds. Many small fish were observed in the water at the mouth of the effluent pipe. The attendant stated that there are always fish at this point.

A slight musty odor was noticeable at and about the beds, but appeared to come from the sewage soaked wood rather than from the sewage itself. At a distance of 400 or 500 ft. from the beds, facing a strong breeze from that direction, a slight odor, not especially unpleasant, was noticed. The effluent beneath the beds was found to be cloudy, which, with the presence of the fish at the mouth of the effluent pipe, as though securing food there, appeared to indicate that appreciable quantities of solid matter were passing through the beds. But notwithstanding the color of the effluent and the presence of the fish, the creek showed but a very slight pollution.

The fish just spoken of do not necessarily feed

TABLE I.—Daily Pumpage of Sewage in Thousands of Gallons at Atlantic City, N. J., from Dec. 1, 1891, to Nov. 30, 1892.

	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	
1	1,642	1,549	1,728	1,940 R	1,410	1,998 S	2,116	3,456 R	2,925	2,851	3,212	1,941	1
2	1,604	1,749 R	1,711	1,812	1,229	1,996	2,093	3,390	2,979	2,721	2,250 S	2,087	2
3	1,529	1,643 S	1,681	1,824	1,760 S	2,002	2,064	3,185 S	2,999	2,614	2,120	1,990	3
4	1,569 R	1,625	1,673	1,807	1,842	1,997	2,179	3,938 R¹	2,862	3,001 S	2,208	2,133 R	4
5	1,638	1,615	1,719	1,767	1,762	1,832	2,218 S	3,498	2,822	2,897	2,208	1,992	5
6	1,530 S	1,740 R	1,757	1,647 S	1,871	1,965	2,133	3,106	2,837	2,797	2,200	2,026 S	6
7	1,547 R	1,702	1,682 SR	1,705	1,965	1,897	2,112	3,087	2,880 S	2,681	2,101	1,928 R²	7
8	1,670	1,694	1,633	1,740 R	2,083 R	1,974 S	2,018	2,905	2,897	2,663	2,207	2,059	8
9	1,698	1,681	1,621	1,845	2,012 R	1,893	2,170 R	2,879	2,936	2,657	1,949 S	2,070	9
10	1,612	1,722 S	1,623 R	1,751 R	1,858 S	1,710	2,537 R	2,877 S	2,907	2,444	2,175	2,298 R	10
11	1,662	1,504 R	1,651	1,743	1,826	2,214 R	2,382	2,730	2,808	2,517 S	2,187	2,144	11
12	1,538	1,665	1,632	1,758	1,822	1,920	2,309 S	2,756	2,922 R¹	2,475	2,119	2,479	12
13	1,561 S	1,794 R	1,720	1,745 S	1,818	2,082	2,602	2,852	2,976	2,477	1,938	2,550 S	13
14	1,559	1,649 R	1,694 S	1,732	1,911 R	1,979	2,416	2,874 R	3,004 S	2,515 R	1,947	2,419	14
15	1,569	1,712 R	1,709	1,651	2,057 R	2,165 S	2,442	2,820	3,181	2,486	1,933	2,600 R	15
16	1,637 R	1,751	1,626	1,604	2,062	2,515 R¹	2,509	2,762	3,090	2,400	1,920 S	2,673 R	16
17	1,536	1,728 S	1,655	1,678	2,034 S	2,401	2,180	2,865 S	3,083	2,551	1,941	2,999	17
18	1,602	1,777 R	1,681	1,862 R	1,921	2,275	2,291	2,927	2,915	2,392 S	1,950	2,819 R	18
19	1,530	1,739 R	1,775	2,328	1,922	2,184	2,214 S	2,775 R	2,854	2,382	1,880	2,358	19
20	1,585 S	1,807	1,726 R	2,208 S	1,847	2,271 R¹	2,293	3,466	2,912	2,338	1,952	2,374 S	20
21	1,561	1,796	1,676 SR	1,920	1,851 R	2,427 R	2,453	3,264	2,968 SR	2,347	2,168	2,362	21
22	1,542	1,740	1,746	2,004	2,451 R	2,260 SR	2,271	3,091	3,147	2,313 R	2,037	2,313	22
23	1,540	1,712	1,728	1,932 R	2,087	2,382	2,293	2,967	3,135	2,391	2,101 S	2,332	23
24	1,503 R	1,608 S	1,702	1,974	1,985 S	2,304	2,237	2,955 S	3,207 R	2,389	2,061	2,343	24
25	1,579	1,634	1,765	1,917	1,933	2,224	2,355	2,890	3,168 R	2,289 S	2,060	2,380	25
26	1,507	1,830	1,750	1,824 R	1,989	2,097	2,485 S	3,153	3,269	2,475 R	2,020	2,297	26
27	1,527 S	1,742	1,708	1,592 SR	1,911	2,191	2,387	2,881	3,128	2,244	2,029	2,141 S	27
28	1,563	1,739	1,728 S	2,074	1,821	2,216	2,368	2,821	3,150 SR	2,285	2,074	2,351 R	28
29	1,616 R	1,721	1,874	1,933	1,801 R	2,132 S	2,388	2,811	3,054	2,231	2,049	2,069 R	29
30	1,758 R	1,700	.....	1,889	1,596	2,029	2,369 R	2,865	2,813	2,278	2,014 S	2,019	30
31	1,623	1,680 S	....	1,824	.....	2,048	.....	2,998 SR	2,829	.....	1,994	....	31
Total	49,109*	53,748	49,556	57,419	56,735	65,622	68,870	93,935	92,907	75,102	64,171	68,719	
Average.	1,584	1,701	1,709	1,852	1,891	2,117	2,296	3,030	3,000	2,503	2,070	2,291	Year

S = Sunday. R = Rain. R¹ = Heavy rain previous night. R² = Rain previous night.
* Footings may not correspond exactly with totals given, as former include the odd figures omitted from hundreds column.

directly on solid matter from the sewage effluent, but may feed upon lower forms of life, which, in turn, feed upon the organic matter in the effluent.

The removal of the solid matter by straining is the principal object of the beds as now operated, and not the nitrification of objectionable organic matter in the sewage. That only the grosser particles of solid matter can be removed by the beds is evident from the rapid rate of filtration, as shown by the pumping records of the year ending Nov. 30, 1892, as follows:

Assuming that the available filtering surface is 3,800 sq. ft., the minimum amount of sewage filtered in one day during the year was 323 gallons per sq. ft. of filtering surface, or about 14,000,000 gallons per acre. The average daily rate of filtration for the whole year was 573 gallons per sq. ft., or nearly 25,000,000 gallons per acre. The month of July showed the greatest total pumpage of sewage of any month of the year, and gave a rate of 791 gallons per sq. ft., or nearly 34,000,000 gallons per acre, while the greatest pumpage in any one day during the year was at the rate of 1,036 gallons per sq. ft. of filtering area, or nearly 45,000,000 gallons per acre. When it is remembered that intermittent downward filtration through sand filter beds to the amount of 100,000 gallons per acre per day is a fair if not a high rate of filtration, it will be seen that only a very partial purification was effected during the year at Atlantic City, for, on an average, the sewage passed through the beds 250 times as fast as is consistent with thorough purification.

There has been no trouble with frost at the beds, it is stated, and at times in the winter the only open place in the creek is at the mouth of the effluent pipe.

The cost of the various parts of the disposal system is reported as $5,000 for the station and well, about $15,000 for the pumps and boilers, and some $1,500 for the last filter beds.

To operate the pumping station one engineer, at $75 a month, who makes necessary repairs, and two at $45 per month are employed. The yearly cost of coal is given as $1,200, and of lights, $50. A man is employed constantly at the filter beds at a salary of $40 per month, and for about eight months in the year an extra man is employed more or less of the time at $1.50 per day, more especially to aid in getting sand from the creek. Allowing 20 days' work per month for eight months for this extra man, the yearly cost of labor at the pumping station and filter beds is $2,700, which, with $1,200 for coal, $50 for lights, makes the total cost of operating the pumps and filter beds $3,950, not including incidentals. On the above basis the cost of operating the filter beds alone is $720 per annum.

Daily records of pumpage and coal consumption are kept by the company. The pump register is read at 12 m. each day, allowances being made for slip and wear of the plunger. The diagram, Fig. 61, shows the pumpage of sewage for each day from Dec. 1, 1891, to Nov. 30, 1892. The diagram also shows the rainy days of the year, and the maximum and minimum temperature of each month, by dates. The figures from which the diagram was compiled are given to the nearest thousand in Table I. Sundays and rainy days are indicated both in Table I. and the diagram, Fig. 61.

For an understanding of the diagram and the accompanying tables, it is necessary to state that there are two seasons at Atlantic City, a winter and a summer. The winter season begins about Jan. 15, and is said to continue often until June 15, when the summer season opens. In July and August it is said that in 1892 the average population was 100,000. The resident population is at present about 15,000.

It is stated that there are over 600 hotels and boarding houses and nearly 4,000 houses in the city.

That not all of the buildings are supplied with water, and that all so supplied are not connected with the sewers, is shown by the following figures:

	Number of taps.			No. of sewer connections.	Excess of water over sewer connections.	
Dec.	Atlantic City Water-Wks Co.	Consumers Water Co.	Total.		Number.	Per cent.
1891	2,273	500	2,773	1,849	924	50
1892	2,463	500	2,963	2,140	823	38

The relative average daily amounts of water consumed and of sewage pumped from Dec. 1, 1891, to Nov. 30, 1892, are shown in Table II., the figures for the Consumers' Water Co. not being based on accurate records, but being estimated by the engineer of the company for use in this connection.

TABLE II.—Average Daily Water Consumption and Sewage Pumpage, by Months, at Atlantic City, N. J., from December, 1891, to November, 1892.

	Average daily consumption of water.			Average daily sewage pumpage.	Excess water over sewage.	
	Atl. Cy. W. W. Co.	Consumers' W. Co.	Total.		Amt.	Per cent.
Dec.	1,863,575	330,000	2,193,575	1,583,867	609,708	34
Jan.	1,990,374	380,000	2,340,374	1,701,537	638,837	37
Feb.	2,162,669	450,000	2,612,669	1,708,832	903,837	53
March.	2,376,137	470,000	2,846,137	1,852,237	993,900	54
April.	2,513,735	500,000	3,013,735	1,891,182	1,152,553	61
May.	3,003,077	480,000	3,486,077	2,116,843	1,369,234	64
June.	2,604,730	518,000	3,122,730	2,295,652	827,078	36
July.	2,815,731	550,000	3,365,731	3,030,156	335,575	11
Aug.	3,550,273	540,000	4,090,273	2,993,913	1,090,360	36
Sept.	3,854,781	535,000	4,389,781	2,503,404	1,886,377	75
Oct.	2,919,584	520,000	3,439,584	2,070,024	1,369,560	63
Nov.	2,232,419	475,000	2,707,419	2,29,624	416,795	18
Year.			3,142,682	2,172,059	970,623	45

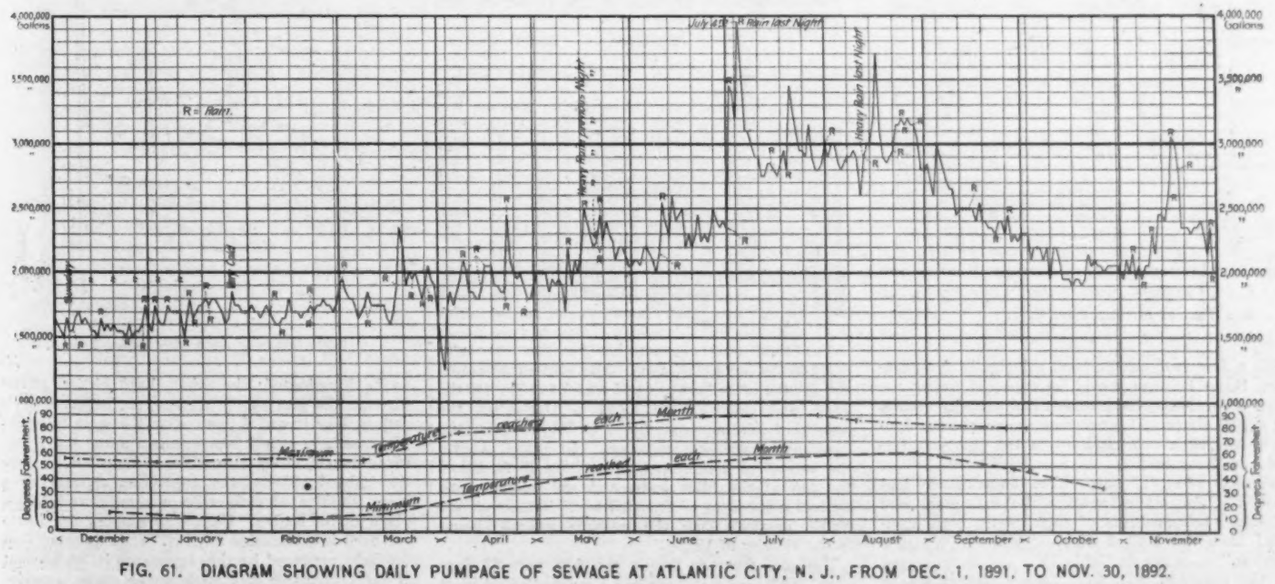


FIG. 61. DIAGRAM SHOWING DAILY PUMPAGE OF SEWAGE AT ATLANTIC CITY, N. J., FROM DEC. 1, 1891, TO NOV. 30, 1892.

These figures show that the excess of average daily water consumption over sewage pumped ranged from 11% in July to 75% in September, and averaged 45% for the year. As stated above, there were 50% more water taps than sewage connections at the beginning of the year, and 38% at its close. The relative monthly consumption of water and pumpage of sewage is also shown graphically by the diagram, Fig. 62.

The greatest amount of sewage pumped in any one day during the year was 3,937,720 gallons, which, it is interesting to note, was on July 4, on which date a large crowd of people generally visits the city. The least pumpage on one day was on April 2. The maximum and minimum daily pumpage for each month in the year, with the date of the same, and also the variation between the two, the average for the month and the number of sewer connections on the first of each month are shown by Table III.

TABLE III.—Maximum and Minimum Daily Pumpage of Sewage, by Months, at Atlantic City, N. J., for the Year ending with November, 1892.

	No. sewer connections first of each month.	Average.	Maximum. Amount.	Date.	Minimum. Amount.	Date.	Variation.
December	1,849	1,583,867	1,737,760[1]	30	1,502,592[2]	24	235,168
January	1,887	1,701,537	1,870,455[3]	26	1,563,744[4]	11	306,698
February	1,892	1,708,832	1,873,728	22	1,620,672	9	253,056
March	1,910	1,852,237	2,325,192[4]	19	1,610,584	16	714,608
April	1,912	1,891,182	2,450,784[4]	22	1,228,896	2	1,221,888
May	1,961	2,116,843	2,515,581[5]	16	1,710,112	10	805,472
June	2,004	2,295,652	2,601,888	13	2,017,728	8	584,160
July	2,035	3,030,156	3,937,720[6]	4	2,730,144	11	1,207,576
August	2,051	2,999,913	3,699,344	16	2,607,744	11	1,091,600
September	2,061	2,503,404	3,001,440	4	2,230,656	29	770,784
October	2,081	2,070,024	2,312,160	1	1,883,512	19	473,648
November	2,109[7]	2,290,624	3,072,864[1]	16	1,927,584[8]	7	1,145,280
Year	....	2,172,059	2,937,720	..	1,228,896	..	1,708,824

[1] Rain on this and preceding days. [2] Very cold. [3] Rain. [4] Rain previous day. [5] Heavy rain previous night. [6] Rain previous night [7] 2,140 on Dec. 1, 1892. [8] Rain in night.

It will be seen by referring to the diagram, Fig. 61, and Table I., showing each day's pumpage for the year, that nearly every rainy day was accompanied or followed by an increase in the amount of sewage. The foot notes to Table III. show that for six months of the 12 the maximum pumpage was preceded or accompanied by rain, but the same was true of the minimum pumpage of three of the 12 months, though no heavy rains are mentioned in connection with minimum as with maximum pumpage. As has been stated, the separate system of sewsr is in use at Atlantic City,

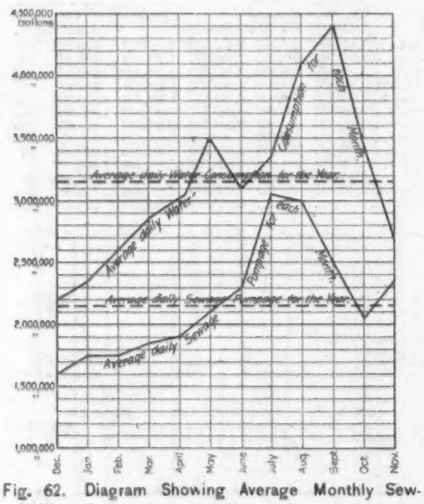


Fig. 62. Diagram Showing Average Monthly Sewage Pumpage and Water Consumption for One Year at Atlantic City, N. J.

with a few roof connections, principally for flushing. Some leakage would be expected under the most favorable circumstances, and actually occurs, as stated above. The maximum pumpage for January was on a day reported in the pumpage records as "very cold."

To see what, if any, effect temperature had upon the amount of sewage the maximum and minimum temperatures of each month were compiled from the United States "Monthly Weather Review," as given in Table IV., and then plotted on the diagram, Fig. 61. Low temperatures in winter, through waste of water to keep plumbing from freezing, and high temperatures in summer, might be expected to cause an increase in the amount of sewage, and doubtless do, but the figures compiled and plotted have a bearing upon only two days in each month, and are of little or no help in the study. Unfortunately, the "Weather Review" does not give daily temperatures, which would be of interest and value in this connection. As showing something of the temperatures of the whole of each month, the mean maximum, mean minimum, and the half of the sum of the two are given below for the year, in connection with the maximum and minimum temperatures and their dates. The total monthly precipitation and the average pumpage of sewage for each month is also given at the right, as of interest in this connection. The figures for November were not available.

TABLE IV.—Monthly Temperatures and Precipitation at Atlantic City, N. J., for Eleven Months ending with October, 1890.

	Degrees Fahrenheit. Max.	Date of max.	Min.	Date of min.	Mean max.	Mean min.	Mean max. and min. ÷ 2.	Precipitation, ins.	Av. daily sewage pumpage.
December	56	4	15	18	48	31	41.0	3.19	1,583,867
January	63	2	10	21	39	26	32.5	3.02	1,701,537
February	57	8	10	13	40	29	34.5	1.43	1,708,832
March	55	7	14	15	42	28	35.0	3.69	1,852,237
April	76	6	28	12	53	40	46.5	3.05	1,891,182
May	90	16	40	8	64	51	57.5	5.51	2,116,843
June	89	22	51	11	74	63	68.5	4.44	2,295,652
July	90	28	57	8	76	64	70.0	4.23	3,030,156
August	86	9	61	28	79	68	73.5	3.26	2,999,913
September	80	25	18	27	72	59	65.5	1.08	2,503,404
October	80	1	33	25	63	47	55.0	0.30	2,070,624

The total and average daily coal consumption for each month, and also per million of gallons pumped, are given below, together with the number of sewer connections on the first of each month, and the total and average daily pumpage for the month is shown by Table V.

TABLE V.—Monthly Sewage Pumpage and Coal Consumption at Atlantic City, N. J., for the Year ending with November, 1892.

	No. sewer connections.	Pumpage, galls. Total.	Average daily.	Coal consumed, lbs. Total.	Average daily.	Per million galls.
December	1,849	49,099,872	1,583,867	70,720	2,268	1,440
January	1,887	52,747,646	1,701,537	68,340	2,205	1,296
February	1,892	49,556,140	1,708,832	58,720	2,025	1,184
March	1,910	57,419,360	1,852,237	71,680	2,312	1,249
April	1,912	56,735,460	1,891,182	70,400	2,347	1,242
May	1,961	65,622,119	2,116,843	87,360	2,818	1,332
June	2,004	68,869,560	2,295,652	82,560	2,752	1,198
July	2,035	93,934,840	3,030,156	91,040	2,937	969
August	2,051	92,997,306	2,999,913	92,320	2,985	990
September	2,061	65,102,102	2,503,404	77,280	2,576	1,029
October	2,081	64,170,748	2,070,024	70,324	2,268	1,095
November	2,109*	68,718,734	2,290,624	72,200	2,407	1,051
Year	.....	794,973,877	2,172,059	913,140	2,495	1,149
Av per month	....	66,247,823	.....	76,095	....	....

*2,140 on Dec. 1, 1892.

The total coal consumption for the year was 913,140 lbs. or 456.57 tons. The coal consumption per million of gallons pumped was 1,149 lbs. for the year, and ranged from 1,440 in December, the month of minimum pumpage, to 969 in July, the month of maximum pumpage. As stated above, the bottom of the pump well is about 25 ft. below the top of the filter beds, and the pumps work against a pressure of from 15 to 25 lbs., as shown by the pressure gage, the pressure generally being in the vicinity of 15 lbs.

The cold weather during the first part of January, 1893, seems to have had a marked effect upon the amount of sewage, the temperature and pumpage for each of the first 20 days of the month having been as follows, the thermometer and pump register being read at 12 m. each day.

The average daily pumpage for January, 1892, was 1,701,537, against 2,267,163 for the first 20 days of January, 1893, and 2,172,059 for the year ending Nov. 30, 1891. The number of sewer connections increased only about 16% between January, 1892, and January, 1893, while the daily amount of sewage pumped in the first 20 days of January, 1893, was about 33% greater than the average for January, 1892. For the year ending Nov. 30, 1892, the lightest pumpage was in the month of January. From these figures it appears that the recent cold weather greatly increased the amount of sewage at Atlantic City, although there may

	Temperature. F. °.	Pumpage. galls.		Temperature. F. °.	Pumpage. galls.
Jan. 1	40	2,179,584	Jan. 12	22	2,263,168
2	38	2,199,936	13	9	2,401,344
3	29	2,194,944	14	12	2,497,152
4	18	2,250,528	15	18	2,304,960
5	24	2,143,776	16	4	2,295,360
6	24	2,152,472	17	6	2,312,352
7	18	2,173,632	18	10	2,343,360
8	22	2,191,776	19	21	2,246,208
9	24	2,208,288	20	16	2,261,160
10	14	2,263,968			
11	7	2,326,272	Total		45,343,250
			Averages	19	2,267,163

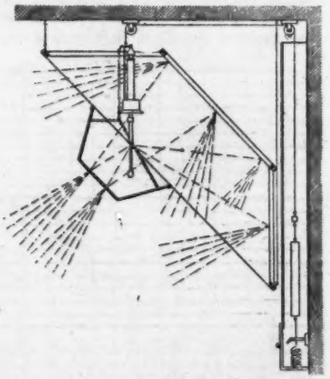
have been other causes contributing largely to the increase, such as an unusually large number of visitors in the city, which seems hardly probable.

We are indebted for the above information to the president of the company, Mr. A. J. Robinson, of New York; to Mr. J. J. Deery, of the National Sewerage & Sewage Utilization Co., of New York; to the Atlantic City Water-Works Co., and the Consumers' Water Co., of Atlantic City; and especially to Mr. A. M. Jordan, of Atlantic City, who is superintendent of the company.

LIGHT DIFFUSING APPARATUS FOR ARC LAMPS.

An apparatus which, in a very simple manner, effects an efficient diffusion of the light of an arc lamp of very high intensity and seems, therefore, to be especially adapted for drafting rooms, studios, schools, museums, exhibitions, etc., is described in "Glaser's Annalen."

Fig. 1 shows the general arrangement of the apparatus. Two reflectors of different size, of which the smaller is placed eccentrically to the larger one, are secured to the wall. The smaller reflector consists of transparent material. The arc light is so arranged that its focus will coincide with the center of the small reflector. Half of the light emitted from the focus is deflected in the large or main reflector, and is thrown upon the object



Light Diffusing Apparatus for Arc Lamps.

to be illuminated; the other half either passes through the smaller, or transparent reflector, or is deflected by it and thrown upon the main reflector. Thus, only a small loss occurs during the transformation of direct into diffused light. Seen from the lighted objects, the apparatus appears as a large illuminated disk, with a somewhat brighter place in its center. Usually 9 ampere arc lights are used in connection with it. It is asserted that the light produced by this apparatus is, on account of its uniformity and unchangeableness, superior to daylight. The apparatus is manufactured by the "Allgemeine Electricitaets-Gesellschaft, Berlin," Germany.

The anthracite coal output for 1892 was 41,893,320 tons, exceeding that of any other year, and the 40,446,336 tons of 1891. Of this total the Schuylkill region furnished 12,626,784 tons; the Lehigh region, 6,451,076 tons, and the Wyoming, 22,815,480 tons; ow a percentage of 30.14, 15.40 and 54.46, respectively.

WILLIAM METCALF, PRESIDENT AMERICAN SOCIETY OF CIVIL ENGINEERS.

(With inset.)

Mr. William Metcalf, elected President of the American Society of Civil Engineers at the January meeting of the Society, was born in Pittsburg, Pa., Sept. 3, 1838. He was graduated from the Rensselaer Polytechnic Institute in 1858, and at once entered the service of the Fort Pitt Foundry Co., of Pittsburg, as a draftsman. About one year later he was made general superintendent or manager of this company, and remained in that position until some time in 1865. During this time, and under the direct supervision of Mr. Metcalf, some thousands of heavy guns and a vast quantity of projectiles were made by this foundry for the United States government.

In 1865, Mr. Metcalf joined the firm of Charles Knap, Nephews, and with them leased and operated the Fort Pitt Foundry plant until late in 1867, when the firm was succeeded by the Knap Fort Pitt Foundry Co. Mr. Metcalf became a member on Jan. 1, 1868, of the firm of Miller, Barr & Parkin, proprietors of the Crescent Steel Works, Pittsburg; the firm name was changed to Miller, Metcalf & Parkin in 1875, and in 1889 it was incorporated as the Crescent Steel Co., the proprietorship remaining practically the same. Mr. Metcalf is now the Managing Director of this steel company.

During his 25 years' connection with the manfacture of steel Mr. Metcalf has been engaged almost entirely in the engineering part of this industry, or in the study of the metallurgy and physics of steel; and in this branch of the engineering profession he has made his name widely known, and his opinions everywhere respected as an expert in that metal. His views upon this subject have been presented to engineers and metallurgists in a number of papers presented at various times to the American Society of Civil Engineers, the American Society of Mechanical Engineers, American Society of Mining Engineers, and to the Engineering Society of Western Pennsylvania. He has been a member of the governing board of each of these societies at different times; was twice President of the last named society, and is now President of the foremost American engineering society.

Personally Mr. Metcalf is active, a hard worker, with excellent executive ability; and as an efficient backing to these qualities he possesses that charm of manner calculated to make him popular among his fellow engineers. He is a fluent speaker and an admirable presiding officer, as was proven at the Cresson Convention of the Society in 1890. These qualifications well fit him for the duties which he will be called upon to perform this year in connection with the engineering congresses at the Chicago Exposition.

THE CITY ELECTRIC STREET RAILWAY POWER STATION OF LITTLE ROCK, ARK., AND ITS RECORD.

By J. B. Arnold, Consulting Engineer.

(Concluded from p. 76.)

Shafting.—The shafting now running consists of about 50 ft. of 6 7-16-in. hammered iron shafting, turned and polished, with five 65×62×15 friction clutch pulleys, with the necessary plain pulleys, tighteners, etc., to receive the power from the two large engines now installed. The shafting is divided near the center, so that one portion of it can be kept going in case of a hot bearing on either part. The cap stones are set, and the bolt holes made in the foundations ready to receive the line shaft for driving the electric lighting machinery, when the time comes for placing it.

The shafting runs at a speed of 280 revs. per minute and the diameters were determined by the following formula:

$$D \sqrt{\frac{56 \times HP.}{R}},$$

where D = diameter of the shaft in inches; R = revolutions per minute, and HP. = horse-power transmitted.

It has been found that in locating the shafting for electric railway work it is best to place the bearings not over 8 or 10 ft. apart, and leave space for not over three pulleys between any two bearings, and preferably two pulleys, when the units of the generating power are large. This arrangement, when the pulley is placed next to the box, gives the pull of the belt almost directly on the boxes, thereby avoiding as much as possible the bending movement of the shaft.

Belting.—There are at present two main belts in the plant, one of which is 54 ins. wide and 135 ft. long, the other is 36 ins. wide and 125 ft. long. These belts transmit the power from the engines to the line shaft. There are five 14-in. belts, which transmit the power from the line shafting to the railway generators.

The belting was calculated from the well known formula $HP. = \frac{D \times R \times W.}{1925}$ where D = diameter of shaft, R = revolutions per minute, and W = width of double leather belt in inches, which assumes a strain of 45 lbs. per inch width of single leather belt.

Piping System (Figs. 3, 4 and 5).—The piping of this plant is arranged in duplicate throughout, so that it is unnecessary to shut down on account of the breaking of the piping. There are two 14-in. water connections from the river to the outside well, two 12-in. suction pipes from the outer well to the air pump and boiler feed pumps, and two 4-in. risers from the boiler feed pumps to the main 4½-in. headers, which extend across the boiler room for supplying feed water to the boilers. These risers are arranged with suitable valves and cross-connections, so that either pump will deliver water up either riser through either header to the boilers, either through the live steam purifiers or directly into the boilers, as the engineer desires. The suction pipes to the pumps are arranged so that the water can be taken from the hot wells of either the surface or the jet condensers, the outside well, or direct from the river. The condenser air pumps are so piped that the plant can be run either jet or surface condensing, or both at the same time. The overflow pipe from the condenser is placed about 4 ft. above the average water line in the river, and the air pumps are low enough to permit the condensing water to flow into the air pumps when the river is at its normal stage, thereby saving the energy that would be required to lift the condensing water were the air pumps placed higher. The auxiliary overflow pipe is placed, 2 ft. above the extreme high water line, and the piping is so arranged that when the river rises to the above overflow pipe, the water from the condenser can be delivered through the auxiliary pipe. This pipe has already proved its usefulness, as the plant was operated successfully through the recent Southern floods, which brought the water to the highest point since the extraordinary floods of 1844. The plant operated successfully through the entire time without being in the least inconvenienced.

Over each boiler is placed a live steam purifier, and the piping is so arranged that the boiler feed pumps deliver feed water into the boilers through these purifiers or directly into the boilers, as desired. Arrangements are made whereby the steam and water valves for the condensing system and boiler feed pumps are all handled by wheels placed on the level of the boiler room floor, making it unnecessary for the engineer to go down into the condenser pit, except for making repairs or for changing over from one system of condensing to the other.

An iron spiral stairway extends to the bottom of the pit and the top of the pit is left opened for ventilation, except in front of the boilers, where it is covered with a concrete floor to allow firing space for the boilers immediately in front of it. The exhaust steam from the engines is led through pipes under the engine room floor and through a 24-in. pipe located in a tunnel under the boiler room to the condensers in the pit, while an auxiliary 20-in. pipe is led through the same tunnel out through the building to the river, into which all the drain pipes and auxiliary exhausts are led, so that there is no blowing of steam or waste visible in the plant. This pipe is used only for exhaust steam in case of accident to the condensers, and automatic relief valves are placed between each engine and this pipe, which will open in case of accident to the condenser, thereby permitting the exhaust steam to go directly to the atmosphere without the attention of the engineer. On top of the dome of each boiler is placed a tee, out of which leads the main 8-in. steam pipe from each boiler to the main 14-in. header which extends entirely across the boiler room. From the other side of this tee extends an auxiliary 7-in. pipe running to the auxiliary 12-in. header, which also extends the entire length of the boiler room. It will be noticed that each boiler is piped independently to both main and auxiliary steam headers, and suitable valves are placed for supplying either header as the case demands. The steam pipes to each engine joined to both headers and valves are placed so that the steam can be taken from either pipe. Bronze seated valves are used throughout the entire plant wherever high-pressure steam or water comes into contact with them, and lighter valves are used on the exhaust connections. The exhaust steam from the steam cylinders of the condensers and boiler feed pumps is passed through a small tubular heater and thence to the auxiliary exhaust pipe. The boiler feed pumps deliver the feed water through this heater, thereby absorbing whatever heat there is in this exhaust, which would ordinarily be wasted. Arrangements are provided so that the exhaust from the condensers and boiler feed pumps can be turned into condensers, thereby getting the benefit of the vacuum in case the heater is not used. By opening and closing certain valves, the water can be shut out of the outside well, thereby permitting the filter to be cleaned. While this is being done, the pumps draw their supply directly from the river.

Fire Service System.—From the boiler feed pumps runs a 4-in. vertical riser through all the stories to the top of the building, off from which on each floor runs a system of horizontal pipes 3 ins. in diameter, with hydrants located at suitable places. These hydrants are provided with hose and reels and are always in readiness in case of fire. There is an electrical bell system placed in the plant whereby the engineer can be signaled by any one in any portion of the building in case a fire breaks out. The pressure from the boiler feed pumps is always on the fire service pipes, and an automatic arrangement is provided whereby the boiler feed pumps can be turned into fire service pumps almost immediately. It will be remembered that each one of these pumps is amply large to supply the plant, so that one pump is always in reserve for fire service. The supply of water for the water car which sprinkles the track of the road, and also the water for sanitary service in the building, is supplied from the fire service pipes, so there is no water consumed in the building from the city, although the system of piping is connected to the city mains as an extra precaution.

Engine Room Gage Board.—Located in the engine room in plain view of the engineer and immediately behind the boilers is a polished oak gage board, upon which are mounted an auxiliary steam gage, glass water gage and gage cocks for each boiler, besides the necessary vacuum gages, clocks, recording steam gages, etc., enabling the engineer on duty to keep a constant check upon his firemen who handle the water and steam.

Building Construction.—The outside walls of the building from the foundation to the dynamo room floor are composed of brick laid in cement mortar composed of one part Louisville cement to two parts of sand. From the dynamo room floor to the car barn floor the walls are 18 ins. thick, and from this point to the roof 12 ins. thick, with 6-in. pilasters. From the dynamo room floor to the top the brick are laid in lime mortar composed of one part lime to two parts of sand. The boiler room floor (as well as all other concrete work) is composed of one part of Louisville cement to two parts of sand and five parts of broken granite, and the surface of the floor is brought to a true level with pure portland cement. The engine room floor is built of 2×10-in. joists spaced 12 ins. apart and covered with 2×8-in. plank. Over this surface is a finished, matched and dressed hard pine floor. The columns supporting the upper floors and roof are as follows: In the boiler room there are hollow cast iron round columns 25 ft. long and 10 ins. in diameter, 1⅛ ins. thick. On top of these rest cast iron lintels upon which rest 10-in. square hard pine posts, extending through the dynamo room and supporting the pit room floor. On the top of these posts are other cast iron lintels extending through the 10×16-in. floor joists, which support the pit room floor. Resting upon these lintels are short 10×10-in. posts sustaining the 10×16-in. joists supporting the car barn floor and tracks. On these joists are cast iron caps upon which stand the 8×8-in. square pine posts, supporting the roof, spaced equally distant between the tracks. In the engine room the columns instead of being iron are made of 12×12-in. hard pine posts 20 ft. long. The iron columns, as well as the dynamo room floor, are designed to support a concentrated load of 14 tons with a factor of safety of 6. This was done in order to be able to move the largest generator that will ever be put into a station over the floor from the elevator to its position, without damage to the building.

The dynamo room floor is supported on 10×16-in. joists spaced 3 ft., c. to c. On this is spiked 2×10-in. planking, over which is laid at an angle of 45° 3-in. hard pine flooring, grooved and splined with hard wood splines. This surface is covered with ⅞×3-in. finished hard pine flooring, tongued and grooved, laid at right angles to the walls of the building. The pit room and car house floors are made of 3-in. flooring, grooved and tongued with hard wood splines. The surface of the car barn floor is covered with ⅞-in. dressed hard pine flooring.

The roof of the car house and the floor of the theatre is built of 2×12-in. joists spaced 12 ins. apart, over which is laid 2-in. sheathing. At present this sheathing is covered with one layer of asbestos roofing and covered with two coats of asphalt paint. When the summer theatre is erected, this roof is to be covered with a light asphalt pavement and a light roof placed upon the theatre, covered with canvas painted with white lead and boiled linseed oil.

Track.—There are about 20 miles of road, mostly of the 35-lb. steel T rail, but through the business portion of the city 52-lb. Johnson girder rail placed on chairs is used. The ties are spaced 2½ ft., c. to c., and are mostly sawed oak. There are one double track and 35 single track curves, six turn-outs and one cross over in the system. The track is bonded throughout with No. 0 bond wire, joined to the rails with channel pins. These bond wires are attached to a No. 0 copper-ground wire running the entire length of the track and returning to the power station. These ground wires are at-

tached to old car wheels and other metal plates, which are sunk in old wells and ravines at suitable intervals along the road so as to secure as perfect a ground as possible. The return wires are also attached to the water-works pipes of the city, wherever it is convenient. There are also heavy copper wires running from a switchboard in the dynamo room to the Arkansas River, in the rear of the power house, where the terminals are attached to old car wheels sunk in the river. It will thus be noticed that the rail return circuit of the entire system is as thoroughly grounded as it was practicable to make it.

Overhead Construction.—About 20 miles of No. 0 hard drawn copper wire was used for the trolley system of the road in addition to about 40,000 ft. of No. 000 insulated wire for feeders. The trolleys and feeder systems are supported upon about 1,400 poles, 100 of which are Milliken latticed iron, which are used through the business portion of the city. Special insulators are used on the arms of the iron poles to prevent leakage where there is excessive strain on them caused by curves or turnouts. The cross-suspension method of overhead construction is used throughout, and the poles are set with a small amount of rake, so that when drawn up with the steel span wire they stand perfectly straight and in almost absolute line. The thoroughness of the electrical work will be appreciated when it is known that the first time the current was sent over the line not a ground was discovered or any defect in the electrical construction noticed.

Records of Operation.—In closing it might not be amiss to call attention to some of the peculiar features of this plant, inasmuch as it is a departure from anything of its kind that has yet been built, so far as the writer knows, and invite your attention to the following tabulated statement of the results secured from the plant, extending over a period of two months. These figures are absolutely reliable, the electrical output figures having been taken from the daily records from readings taken at intervals of 30 minutes, while the coal consumption is not estimated, but is the amount actually purchased and used by the plant, including all waste coal used for heating, blacksmithing and driving eighteen half-arc lights and about 200 16-c. p. incandescents used in and outside the building.

1. The general idea of the building, extending up a hillside with the respective stories over-lapping each other, was suggested to the designer by the natural formation of the land, as the level of the electric railway, which the plant was to operate, was about 50 ft. above the level of the steam railway track from which it was to secure its supply of coal.

2. The utilization of a short story for a pit room under all of the cars, thereby allowing cleaning to be done and repairs to be made without switching.

3. Providing a washing pit under each track in the house.

4. Placing the line shafting on the top of the partition walls, thereby making the wall serve a double purpose.

5. The location of the car barn on the top of the power house.

6. The placing of the summer theater on top of the structure, thus securing the entire plant under one roof.

7. The inclination of the tracks of the car barn toward the front of the building, for convenience in case of fire.

8. The economy of the plant as shown by the accompanying tables, which have been prepared from accurately kept daily records extending over the month of July and August, 1892. The daily readings are given in Table No. 1, and the results of deductions given in Table No. 2.

The quantity of coal burned during the two months was accurately weighed so that it is known to be reliable. The electrical horse-power output was taken from hourly readings of a Buss ammeter and a voltmeter, extending over the entire time. The car miles are the results of accurately kept daily records of each car, so that they are correct. We thus have absolutely correct the three important factors, namely: The quantity of coal burned and the cost of same; the electrical horse-power output; and the number of car miles run.

The mechanical and indicated horse-power given on the tables are arrived at on the assumption that the friction of the engine was 10%, and the electrical loss in the dynamo 10%, and the loss in the line shaft 6½%, making a total loss between the indicated horse-power and the electrical horse-power 26½%. It will be noticed that the mechanical and the indicated horse-power are the only factors in this table that are dependent upon assumed values; and, as the assumptions are believed to be correct, it is thought that the table is reliable.

The plant is now running on about ten tons of Coal Hill (Arkansas) slack per day, worth 25 cts. per ton at the mines and costing $1.25 per ton at the power station, so the cost of operation is somewhat less than given in these figures. Inasmuch as no correct records have been kept of the plant when operating on this coal, it is not thought best to make any further claim for economy, until reliable data is obtained. It should be remembered that at the time the daily records were taken from which the above figures are deduced, the operators of the plant had no idea that their figures were to be used as tests. In fact, it was not known by any one at that time that they were to be used for such purpose; but owing to the plant being out of coal July 1 and also Sept. 1 these two months were chosen for the reason that the coal could be accurately determined.

Table I. Daily Record of City Electric Street Railway, Little Rock, Ark., July 1 to Sept. 1, 1892.

Date.	No. motor cars in service.	No. miles run.	Miles per car, ave.	Ave. current amperes.	Ave. voltage.	Ave. HP. Electrical	Ave. HP. M'chan'cl	Ave. HP. Ind.
July 1	22	2,185.70	99.35	360	501	242	278	306
2	21	2,293.50	109.22	348	501	234	269	297
3	22	2,153.84	97.90	359	497	239	275	303
4	20	2,191.98	109.60	378	497	252	290	319
5	20	2,209.20	110.46	340	501	228	263	289
6	20	2,151.76	107.58	356	504	227	261	287
7	20	2,246.69	112.33	333	503	224	258	284
8	21	2,196.97	104.62	335	480	216	248	273
9	21	2,198.39	104.68	343	504	232	267	294
10	19	2,126.99	111.95	330	503	223	256	282
11	20	2,169.32	108.47	339	502	228	263	289
12	20	2,213.19	110.66	358	499	239	275	302
13	20	2,137.15	106.85	328	498	219	252	277
14	21	2,219.57	105.69	325	468	204	234	257
15	20	2,144.42	107.22	357	502	240	276	304
16	20	2,187.17	109.36	345	487	225	259	285
17	20	2,229.37	111.47	339	495	224	259	285
18	21	2,239.70	106.65	350	484	227	261	287
19	21	2,210.27	105.25	358	470	225	259	285
20	20	2,265.61	113.28	353	495	234	269	296
21	20	2,213.88	110.69	344	499	229	264	290
22	21	2,153.80	102.56	355	504	240	276	304
23	20	2,219.90	110.99	341	494	226	260	286
24	21	2,186.83	104.13	355	493	234	270	297
25	20	2,169.43	108.47	332	492	219	252	277
26	20	2,153.37	107.67	336	493	222	255	280
27	20	2,149.53	107.47	357	489	234	269	296
28	21	2,037.84	97.04	363	492	240	276	304
29	22	2,141.19	97.33	336	483	217	250	275
30	20	2,148.28	107.41	342	491	225	259	284
31	21	2,133.48	101.59	344	490	226	260	286
Aug. 1	20	2,076.11	103.80	341	492	225	258	284
2	20	2,152.57	107.63	328	486	214	246	270
3	20	2,117.55	105.87	337	491	221	255	280
4	20	2,151.74	107.58	324	492	214	246	270
5	20	2,149.91	107.49	328	489	215	247	272
6	22	2,066.72	93.94	350	490	230	264	290
7	19	2,004.88	105.52	373	491	245	283	311
8	21	2,080.70	99.08	341	484	222	255	280
9	20	2,153.43	107.67	338	487	220	253	278
10	20	2,149.67	107.48	338	501	227	261	287
11	22	2,223.80	101.08	349	499	233	268	295
12	20	2,126.13	106.30	347	498	232	266	293
13	21	2,152.12	102.48	358	489	235	270	297
14	20	2,122.93	106.14	364	493	241	276	304
15	20	2,156.35	107.81	329	492	217	249	274
16	20	2,130.72	106.53	353	496	234	270	297
17	20	2,141.53	107.07	332	488	217	249	274
18	20	2,135.80	106.79	351	481	226	260	286
19	20	2,155.76	107.78	361	491	238	274	301
20	20	2,177.83	108.89	329	494	218	249	274
21	20	2,128.42	106.42	351	489	230	264	290
22	20	2,128.61	106.43	344	494	228	262	288
23	20	2,123.40	106.17	340	492	224	257	282
24	20	2,126.33	106.31	319	468	200	230	253
25	20	2,000.86	100.49	338	494	224	257	282
26	20	2,144.28	107.21	316	480	204	234	257
27	20	2,143.62	107.18	358	494	237	273	300
28	20	2,206.56	110.32	348	499	233	268	295
29	20	2,141.25	107.06	324	500	217	249	274
30	20	2,151.62	107.58	316	500	212	244	268
31	20	2,139.59	106.98	325	499	217	250	275

Table II. Record of Average Efficiency, Little Rock Street Ry., July and August, 1892.

Total no. car miles run during July and August	133,748.38	
Total no. tons coal burned during July and August	538.	
Average no. lbs. coal (Alabama and Arkansas slack) per car mile run	8.045	
Average no. hours run per day, 17 hours, 58 min.		
Average coal burned per hour, lbs.	966.036	
" " " " day, lbs.	17,354.84	
Average electrical horse power per day	226.52	
Average mechanical " " " "	260.50	
Average indicated " " " "	286.55	
Average no. lbs. coal burned per elec. HP. per hour	4.26	
Average no. lbs. coal burned per mech. HP. per hour	3.71	
Average no. lbs. coal burned per ind. HP. per hour	3.37	
No. of lbs. coal per ton mile run (at car wgt. 5½ tons)	1.463	
Cost of coal per ton	$1.80	
" " " " elec. HP	00.383	cents
" " " " mech. "	00.334	"
" " " " ind. "	00.303	"
" " " " car mile run	00.724	"
" " " " ton " " (at car wgt. 5½ tons)	00.132	"
Cost of power per car mile, including fuel, labor, etc., but exclusive of repairs and interest on investment	01.391	"
No. lbs. coal burned per car per day	867.74	
After Deducting Coal Used for Lighting:		
Average no. lbs. coal per car mile run.	7.55	
No. of lbs. coal per ton mile run (at car wgt. 5½ tons)	1.373	
Cost of coal (Alabama and Arkansas slack at $1.80 per ton) per car mile run	.679	cents
Cost of coal per ton mile run (at car wgt. 5½ tons)	.124	"
No. lbs. coal burned per car per day.	846.74	

The electrical equipment and overhead construction were installed by the Chicago office of the Thomson-Houston Electric Co., under the supervision of Mr. E. E. Downs, one of the constructing engineers of that company. The designer was assisted by Messrs. Rickon & Thompson, architects, Little Rock, Ark., to whom should be given the credit of the artistic portions of the building and details of the upper stories.

The track construction was done under the supervision of H. B .Bradford, General Manager of the local company. To. Mr. H. G. Allis, President of the local company, was due the credit of financiering the enterprise and bringing it to a successful completion.

EXPERIENCES OF ENGINEERS IN THE NAVY.

A correspondent of the "American Machinist" gives the following account of recent experiences of engineers in the naval service, and claims that notwithstanding the great importance of the engineer's work on board ship at the present time, his services are less appreciated now than they were in the early days of the use of steam on shipboard.

I notice that Chief Melville in his report mentions the possibility of an engineer being called from important work "to answer calmly questions regarding the amount of smoke escaping from the funnels."

That this is not an exaggeration the following statement of an actual and recent occurrence will show: The ships, four in number, of the squadron of evolution were slipping comfortably along at about eight knots speed, being on a long run, when the flagship signaled the next in line, "Safety—valve—blowing."

The captain, who was on deck at the time, began to think he was learning something, as he had not noticed any sound, but looking up at one of his pipes, sure enough there was a small show of steam. So the chief engineer was summoned. "Mr. Blank, do you need to have your safety valve blowing?"

"That valve is not blowing, sir; the steam pressure is not within 30 lbs. of it. That steam you see there is from the leaky valve which I told you of three weeks ago as requiring attention, and being a new patent valve, I do not know exactly what is inside of it, and I want plenty of time before me when I start in to overhaul it."

"Well," says the captain, "there is not bunting enough in the fleet to convey that answer, and we have to give it soon; you say the valve is not blowing?" "Yes, sir." "And the admiral says it is, and I must not argue with the admiral with that show of steam at the pipe top."

So the answer went up, "I know it," and the admiral on his flagship ordered, "Stop it," and the answer was, "I cannot." Then the admiral, supposing that some disrespect to his rank, which was only "nickel-plated," or "acting," was intended, ran up the signal, "Commanding officer suspended from duty."

Then at the next port there was a heap of correspondence, and charges and counter charges, during which, as by good luck this engineer was not involved, he used his time to quietly grind in that offending valve. The fleet and the navy department were stirred up for six months over this thing, and all because an acting real admiral would meddle with trifling affairs; he had learned somewhere that it was not "good form" in the English service to show steam at their pipes.

In contrast with this I will give you a little yarn showing how these engineers do things sometimes when left to their own devices:

In the "Remarks" column of the steam log of a United States double-ender low-pressure paddle-wheel boat in the Pacific, 12 midnight to 4 a. m.: "Ran slow from 2:10 until 2:30, while stopping a leak in No. 1 furnace, starboard boiler." This is the leak and how it was stopped:

At 2:10 a. m. the firemen and engineer on watch were startled by a tremendous rush of steam and water and fire and dust in this No. 1 furnace, produced by the breaking and blowing in of a ¾-in. rivet; instantly the engineer sent to the deck and informed the officer there that "he was going to run slow for a little while," at the same time closing the stop valve of the port or uninjured boiler, letting the safety valve take care of its steam. In a few minutes the pressure in starboard boiler was reduced to atmospheric or less, and the surprised firemen reported that the leak had stopped. "Drag out that fire," was now the order, and when it was well cooled off, the front tier of fire bars came out also, and the engineer, stationing his oiler by the engine, which was still running at a good rate, to mind any bells he might get, jumped into the furnace with a ⅞-in. tap, and a short bolt to match it, and the necessary wrenches. The trick was very quickly done, the bars replaced, a new fire started from the other furnaces, the pressure equalized between the boilers, the stop valve opened, and full speed again within 20 minutes.

There was a considerable mental calculation, which went through this man's mind in a very short space of time; he knew that it was a ¾-in. rivet hole to be stopped; that a ⅞-in. tap would go in; that the bolt would match the hole; that he could adjust his throttle

so as to hold a slight minus pressure without doing too much in that direction; but, above all things, that he was favored by the night, which left him free from troublesome questioners; hence his quiet report to the officer of the deck.

NEW BUILDING FOR THE BROOKLYN INSTITUTE.

The trustees of the Brooklyn Institute, Brooklyn, N. Y., have decided to receive competitive plans for the proposed museum of arts and sciences to be erected for the Institute, and the arrangement has been made on a rather novel plan. Five architects, members of the Advisory Board of the Department of Architecture of the Institute, have been specially invited to prepare plans for the proposed buildings, to be handed in April 30, each of the five to be paid $500 for this service. Each architect in the Advisory Board not included among the above five architects has been invited to prepare preliminary sketches for the proposed building, these sketches to be handed in by Feb. 28, for which sketches no compensation is to be paid. An expert jury will select from the sketches submitted in the preliminary competition the three designs of highest merit, and the authors of these three designs will be invited to elaborate and perfect their sketches in the same manner and upon the same scale as the five previously invited competitors, to hand in the completed drawings on April 30, and to receive for their services $500 each. Previous to May 15 the above jury is to report to the trustees which of the eight designs thus submitted possesses, in their judment, the highest merit, with due regard to practical needs, constructive propriety and artistic value. The author of such design will, upon the acceptance of this report by the trustees, and its approval by the Mayor and Park Commissioner, be appointed architect of the museum building, to perfect the design, prepare the working drawings, and supervise their execution. For this work he will be paid the regular commission of 5% upon the actual cost of the work executed from his designs, and proportionally for partial service, but the $500 already paid him will be considered an installment on account of such commission. All drawings and designs will remain the property of their respective authors unless purchased for an adequate consideration by special and mutual arrangement between the parties.

In accordance with this scheme, the following architects, members of the Advisory Board of the Department of Agriculture of the Institute, have been specially invited to submit plans: Louis De-Coppet Berg, of Brooklyn, or the firm of J. C. Cady & Co.; John M. Carrere, of New York, or the firm of Carrere & Hastings; Albert E. Parfitt, of Brooklyn, or the firm of Parfitt Brothers; William B. Tubby, of Brooklyn; and Stanford White, of New York, or the firm of McKim, Mead & White. The jury of experts in the competition will be composed of A. D. F. Hamlin, of New York; Robert S. Peabody, of Boston; and George L. Morse, of Brooklyn. Each set of plans is to be accompanied by a description of the proposed structure. The building will be situated near the Prospect Park reservoir, and may occupy in general a square of about 450×450 ft., the plot being 575 ft. wide, with an average length of 640 ft. The following is an abstract of the general particulars of the building:

While the completed buildings, with the courts, may cover an area of about 200,000 sq. ft., only a small section of the whole can be erected at present. The funds at hand for this purpose amount to $300,000, and it is therefore required to so arrange one section as to form in itself, or with an adjacent court provided with provisional inclosing walls, a complete building fitted for the immediate needs of the Institute. This section should measure not less than 650,000 nor more than 1,000,000 cu. ft., exclusive of the court space.

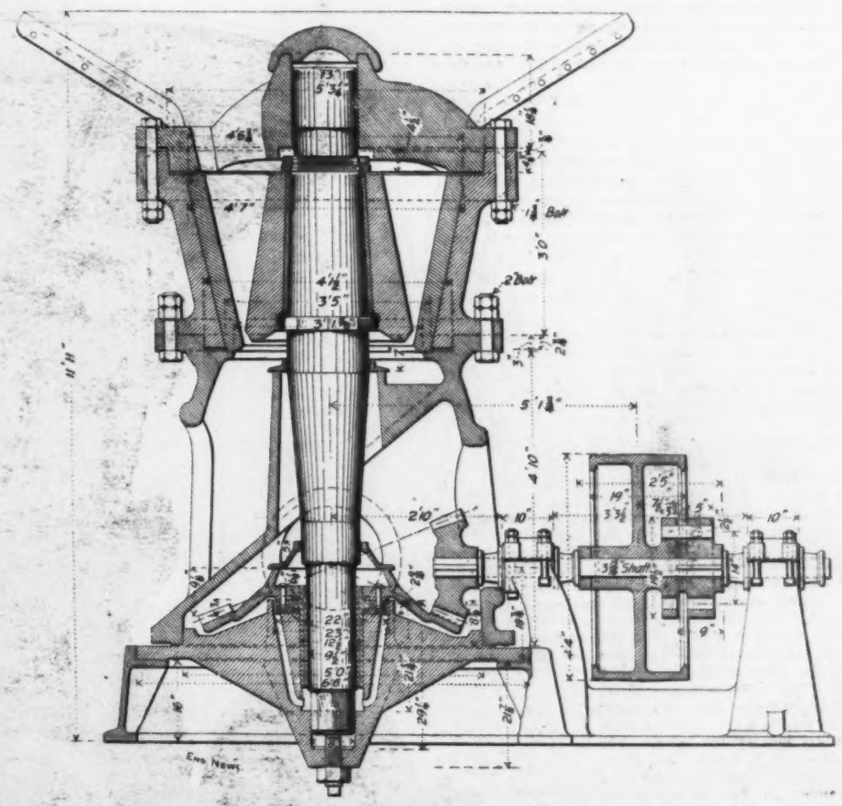
The Trustees, have for the sake of convenience, imagined a rectangular block with interior cruciform arms inclosing four open courts; but this conception of the building is in no way binding on the competitors. It is left to the discretion of the architect to adopt or reject the arrangement of the exhibits of architecture, sculpture and industrial art suggested in the schedule issued by the trustees, and he is equally free (with the exception of the general location of the Scientific Departments in the southern part of the building) to decide whether distinct wings or sections of the building shall be assigned to the several arts or sciences, or whether the division shall be horizontal, by the assignment of different floors to distinct arts or sciences. In other words, he is free to decide whether the visitor shall look for all the subdivisions of natural history, for example, in the different halls of one floor, or on the several floors of one wing, and so with the other sciences or arts. These are matters obviously within the scope of the architect's professional knowledge and experience, and upon which the trustees do not assume to dictate to the architects.

The proposed museum should be simple, dignified and monumental in its proportions and architectural treatment, and freely classical in its general style, but not necessarily and rigidly formal in its use of classic motives. Its interior treatment should be characterized by refinement, without expensive or showy finish. The exterior fronts are to be of light-colored stone, and the court fronts of light-colored brick, terra-cotta, or concrete. The whole structure is to be fireproof, with floors of metal, brick, concrete, etc., the lighter partitions being made of hollow brick or porous terra-cotta or other light materials, and the roof of similar fireproof material covered with tiles or copper, wherever it is not occupied by skylights. There will be no cellar excavated under the ground floor, which will be raised 2 ft. 3 ins. above the ground level, and paved with tile or random mosaic in all the aisles and corridors, and with fine concrete in the courts, and on those portions to be mainly covered by exhibits. Marble or tile may be used for entrance halls or vestibules. The floors of exhibition and department rooms should generally be of wood. With the above limitations, the materials are left to the discretion of the architect.

The building is to be provided with an adequate system of heating and ventilation. The details of the systems to be employed are not called for, but it is suggested that they should be considered in the design, and the most important flues and shafts and conduits should be shown in the plans, while the system provided should be carefully described in the memoir.

As it is in the nature of a museum to constantly enlarge its collections and change its requirements, a large part of the subdivision of the several stories should be effected, not by structural or weight bearing partitions, but by light partitions easily demolished and rebuilt, as occasion may require. This will necessitate a structure completely self-sustaining, independently of its partitions, and having floors strong enough throughout, or at least strong enough at frequent and regularly recurring points, to sustain such light partitions. This consideration (together with the necessity or desirability of treating the basement story with its courts as a continuous area undivided by walls, and only interrupted by piers) suggests the adoption of the steel post-and-girder system of construction for the whole building. This method of construction is further commended for its security against earthquake or other shocks. The posts of the exterior walls will, however, be buried in the masonry of those walls.

There will be four stories to the building, as follows: A ground floor, 16 to 20 ft. in height, easily approached from the street; a first and second story and an upper or roof story, containing the picture galleries, etc., and partly occupying the roof, or wholly below it, the vertical walls of which, in exhibition rooms, should measure nowhere less than 12 ft. high, and with a ceiling not less than 20 ft. above the floor. The first or second story may be a principal story, not less than 18 ft. high nor more than 21 ft. high in the clear, while the other may be a mezzanine or entresol of 12 or 13 ft. high in the clear, or a full story measuring 16 or 18 ft. These heights may be varied in the southern or scientific portion of the building, at the discretion of the architect, even to the extent of dividing into five stories the total height elsewhere occupied by four. The general depth of the building from exterior wall to court-wall should not exceed about 70 ft.



VERTICAL SECTION OF GATES CRUSHER.

The necessary accommodations to be provided include an auditorium for 3,000 persons, an exhibition hall of 30,000 to 35,000 sq. ft., a series of exhibition rooms with a total floor space of 8,000 sq. ft., a library with a floor space of 12,000 sq. ft., five lecture rooms, administration offices, restaurant, toilet rooms, janitor's quarters, etc.

THE GATES ROCK AND ORE CRUSHER.

The rock and ore crusher shown in the accompanying illustrations is one of the largest and most powerful machines of its class ever built. The makers state that when crushing ordinary rock to a size suitable for macadam it can turn out fully 150 cu. yds. per hour, and it requires about 125 HP. to drive it. The machine stands nearly 12 ft. high, and its immense hopper is 11 ft. in diameter. Its total weight is about 32 tons.

The machine is made by the Gates Iron Works, of Chicago, and in its general design follows the lines of the well-known Gates crusher. A few words concerning the general method of operation of this machine will be of interest to those who are not familiar with it. The vertical shaft of the machine is fulcrumed at the top, and its lower end is given a circular motion by an eccentric,

which is rotated by a horizontal bevel gear. When the machine is running empty the vertical shaft rotates, on account of the slight friction of the eccentric, but when material is thrown into the hopper rotation ceases, and the shaft becomes then a lever of enormous power for breaking the rock masses which fall between the chilled cast-iron crushing head and the chilled liners in the sides of the hopper. The eccentric box in this crusher has been given a largely increased area of bearing surface, some 50% in excess of that regularly used, in order to decrease the wear and the liability to heating. The projected area of the bearing is 190 sq. ins.

In the standard Gates crusher the regulation of the size of the crushing is effected as in this machine by raising or lowering the vertical shaft by adjusting the supporting step at the bottom; but in this machine the crushing head has been raised so that its base is some 3 ins. above the bottom of the hopper, and is raised farther to increase the size of the product. In the standard machine the crushing head extends below the hopper, and raising the shaft lessens the size of the crushed material. A new method of fastening the crushing head to the shaft has been adopted in this machine, by which the two parts are held together with less liability to any play, and at the same time they can be easily disengaged when repairs are necessary. Both these features are important, as it has been found by experience that if there is any opportunity for the crushing head to move on the shaft, it will set up vibrations which will crystallize the steel and cause its fracture.

To prevent stripping of the bevel gears if the machine becomes choked, the driving pulley is loose on its shaft, but its hub is connected by a 2½-in. pin to a hub which is fast on the shaft. In case the machine becomes clogged this pin will be sheared off before the teeth on the bevel gear wheels will fail, and can be easily replaced.

It is excellent evidence of the great increase in the use of concrete and of macadam, that a stone crusher of so great a capacity should be placed on the market.

The harbor defense ram "Katahdin" was launched last week at Bath, Me. The ram was designed by Rear Admiral Daniel Ammen. She is 251 ft. long, 43 ft. 5 in. extreme beam, and 22 ft. 10 ins. deep, with a normal draft of 15 ft. and corresponding displacement of 2,240 tons. The lower part of the hull is dish-shaped, and is met 6 ins. below the normal water line by a curved armored deck of 39 ft. radius, thus presenting a sharp knuckle all around. Nothing appears above the water line except the smokestack and ventilators, a conning tower of 18 in. plate, and two light barbettes for four 6-pdr. rapid-fire guns. The ram can be submerged to her fighting level by 14 8-in. Kingston outboard valves, communicating with water-tight compartments of the double bottom. The deck armor tapers from 6 ins., at the outside to 2½ ins. at the crown. The side armor is 6 and 3 ins. thick, and both the side and outer deck armors are heavily backed by yellow-pine. The twin screws are operated by two triple expansion horizontal engines, ith 25, 36 and 56-in. cylinders and 36-in. stroke. The I. HP. is 4,800 and the contract speed is 17 knots.

A sawdust-brick is being experimented with. It is proposed to mix with ordinary clay and and sand about 50% in bulk of fine sawdust; after being well mixed the brick is to be made under heavy pressure, and then burned until the sawdust is completely consumed. The oject is to make a brick of regulation size, but of only about half the weight of ordinary brick, and about one-fourth the crushing strength, for use in interior partition walls, ceilings, etc. The process being followed is practically the same as that used in the production of the so-called terra-cotta lumber.

High grade lumber is being shipped from Duluth, Minn., to South America, via the lakes to Buffalo, to New York by canal and to Rio Janeiro by steamer. One Duluth company shipped last year 10,000,000 ft. B. M. to the same South American port.

WORLD'S COLUMBIAN EXPOSITION.—II.
British Transportation Exhibits.

A partial list of these exhibits, not including many loan exhibits, seems to indicate that the British exhibits in this section will make an excellent show, considering the little trade which Englishmen have in sight as a result of exhibiting. It will be strongest, naturally, in the marine engineering, but probably the most interesting exhibits will be in the railway department. The London & Northwestern alone will show here a full size reproduction of the "Rocket" (which no engineer should fail to see). Trevithick's high-pressure engine of 1803-9, with the identical cars which it drew at that time, a Webb compound express locomotive; a "42-ft. sleeping saloon," model of gridiron sorting sidings, and various other exhibits of almost equal interest. The old and famous broad-gage locomotive "Lord of the Isles," of the Great Western Ry. will also be sent over, and one or two new locomotives.

Among the marine exhibits will be a large collection of models and pictures illustrating the progress of iron in shipbuilding from 1834 to the present time. We trust that among them will be models of the "Alabama" and the two Confederate rams which were finally stopped by the government.

Extensive bicycle, carriage and saddlery exhibits are included in the list, and at least one exhibit of electric vehicles.

Among the comparatively few naval exhibits we are surprised to find John Brown & Co.'s compound armor plate, which would hardly seem worth while after recent events. The same company has an interesting general exhibit. Yarrow & Co. will exhibit models of 27-knot torpedo catchers, and other models. A model of the Forth Bridge, a seamless pressed steel boat, cold drawn steel tubes, wire cables of various kinds, and some other miscellaneous exhibits complete the list, which includes 79 different exhibitors, many of them with large and varied exhibits. And yet the exhibit is by no means all that might be desired, as many features of British transportation practice are very imperfectly represented.

The first number of the Geologic Atlas of the United States will be issued this year by the National Geological Survey, at Washington, D. C. Up to the end of June 30, 1892, an area of 547,000 sq. miles, about one-sixth of our domain, had been surveyed, and 640 map sheets have been completed. Of these 293 were on a scale of 1:62,500; 338 on a scale of 1:125,000, and 81 on a scale of 1:250,000. Hereafter all maps will be on the first of these scales, or about one inch to a mile. Each sheet is printed in three colors; brown for contours of from 5 to 250 ft. each; blue for water, and all names, roads and boundaries are in black.

A MAMMOTH ROCK-BREAKER; CAPACITY, 150 TONS PER HOUR. The Gates Iron Works, Chicago.

THE RE-INFORCEMENT OF WELLS.

By G. D. Hiscox.

The water supply furnished by wells has an importance which is little appreciated in these days of great cities and public water supplies. The great bulk of the people living on farms and in small villages, together with many towns and cities of considerable size are dependent on wells for their supply of potable water. It is a common thing in dry seasons for a well to prove inadequate to the draft upon it. Long continued drought lowers the level of the ground water and decreases the flow in the underground channels, as well as in surface streams. The depth of these subterranean channels varies to a considerable extent with the seasons, rising and falling with increase or deficiency in the rainfall. After a well curb has been put in place and the earth has settled solidly around it, it is a matter of no small difficulty to deepen the well by the old method of digging it out and sinking an inside curb.

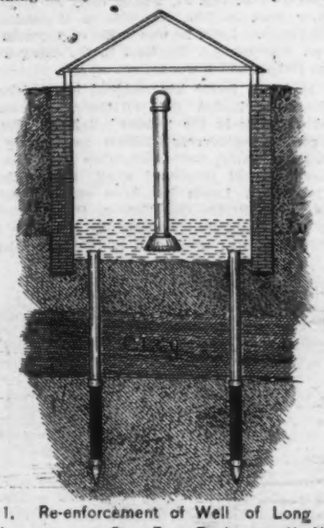


Fig. 1. Re-enforcement of Well of Long Beach Improvement Co.; East Rockaway, N. Y.

In wells having a substratum of gravel, sand, or even quicksand, the most treacherous of water-bearing material, much can be done towards obtaining a greater depth by materials and appliances which can be furnished by an ordinary tin or sheet iron worker or a blacksmith. All that is needed is a driving tube, which may be made of sheet-iron, preferably galvanized, No. 16 or 18 wire gage, and a boring augur, which may be made of the same material. The driving tube should have slits cut over its surface so that it will form a strainer. Before driving the tube, the bottom should be sounded by a pointed ½-in. iron rod to determine where and to what depth the tube may be driven without meeting obstructions. The augur should be 1 to 2 ins. less in diameter than the pipe, and 18 to 20 ins. long. The lower end should have a spiral lip.

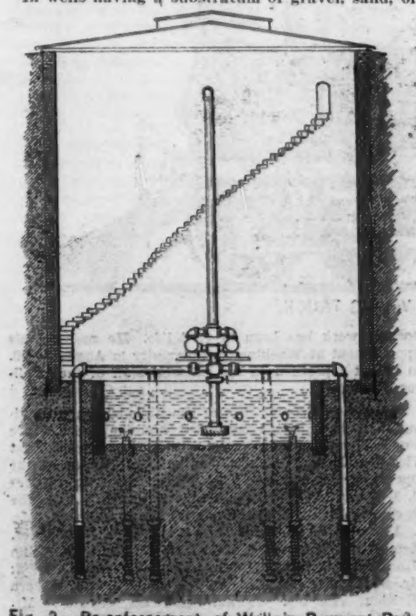


Fig. 2. Re-enforcement of Well in Prospect Park, Brooklyn, N. Y.

In using these tools, the pipe should be settled by gentle driving as fast as the interior is lowered with the sand augur. If a large amount of water or deep driving through gravelly soil is necessary, the driving tube should be made of boiler iron, perforated with ⅜-in. holes. After perforation the pipe should be galvanized and then covered with two layers of brass wire cloth, No. 40 next the pipe and No. 50 on the outside. The wire cloth should be soldered to the pipe at the top and bottom, and at frequent intervals over its surface. In this manner holes 10 to 20 ft. deep may be easily and rapidly sunk in the bottom of wells, and at slight expense.

In case a clay stratum must be penetrated, or boulders may be encountered, it is best to use regular galvanized iron pipe for the drive pipe, and a point or chisel may be screwed on to its lower end to facilitate its penetration. Great care should be taken in fastening the wire gauze to the pipe. It may be attached by machine screws and well soldered at each screw and at the bottom.

This system of reinforcing wells has been long in use by the writer. There are many wells in the vicinity of New York which have been reinforced in the manner above described with the result of a large addition to their old supply; and here and there a dry well has been restored to usefulness.

The great well of the Long Beach Improvement Co., at East Rockaway, L. I., 22 ft. deep and 40 ft. in diameter, on a bottom of quicksand, is a notable instance of the enlargement of flow of water into a well. The reinforcement was made without for a moment disturbing or interfering with the constant and necessary supply of water for the use of the great hotel at Long Beach, and at the height of the season, a time when a day's suspension of the water supply would have been disastrous. In this well, as shown in Fig. 1, two pointed strainers, 6 ins. in internal diameter, were sunk to a depth of 30 ft. below the bottom of the well, over 50 ft. from the surface of the ground, passing through a stratum of clay at a depth of 8 ft. below the bottom of the well, and entering a substratum of water-bearing sand, which is supposed to be fed by the rainfall on the central part of Long Island, judging from the fact that the clay stratum crops out at Pearsall's and along the line of the Brooklyn water-works conduit.

Upon trial, the pressure from the new source of supply raised the water in the pipes 4 ft. above the water surface of the well. The tops of the reinforcing pipes were left 2 ft. above the bottom of the well, and indicated a strong flow when the surface of the water was pumped down within a few inches of their open ends. The output of the well was doubled, the supply capacity rising to 130,000 gallons per day.

The large well of the Lawrence Cordage Co., in the Wallabout quicksand, Brooklyn, which was in progress of filling up by the movement of the quicksand from the excessive pumping of water for a condensing engine, was rescued by a single pipe strainer of 8-in. diameter driven to a depth of 18 ft. below the bottom of the well, with its upper end about a foot above the quicksand bottom. The flow was largely increased, and became equal to the requirement for all purposes.

The great well in Prospect Park, Brooklyn, having a diameter of 50 ft. and a depth of 54 ft. to the water curb, which is 10 ft. deep by 35 ft. diameter, as illustrated in Fig. 2, is probably the most unique well in existence in the peculiarity of its connection with the deep water vein of Long Island. It is a model of what can be done in the reinforcement of a large well. It was at first reinforced with perforated tile pipe, driven horizontally around the water curb, as shown in the cut. This was done to relieve the water pressure from beyond the walls, which had caused a flow over the floor of the curb bench, which is 7½ ft. wide between the main curb and the water curb. This gave a greater area over the waterway, but was not a sufficient reinforcement for the increasing requirement of the Park water-works, as the practical working of the well indicated; for as the surface of the water was pumped down to and below the open ends of the pipes, the flow from them gradually lessened, and finally ceased altogether, at a time when water was most needed. A further reinforcement was made for the purpose of obtaining water from a deeper source by driving four strainer pipes, 4½ ins. internal diameter, to a depth of 20 ft. below the bottom of the well, with open tops projecting 1 ft. above the bottom. In addition to this, four strainer pipes, 6 ins. internal diameter, were sunk through the bench floor between the curbs to a depth of 30 ft. These pipes were connected directly to the pumps, with valves so arranged that the suction could be taken directly from the well, or from the four large driven pipes. Thus, in a dry season, or when more water is needed than the well pump can supply, the direct pump connection with the deep driven pipes will allow of the well being pumped entirely dry, and the water line can be carried many feet below its bottom.

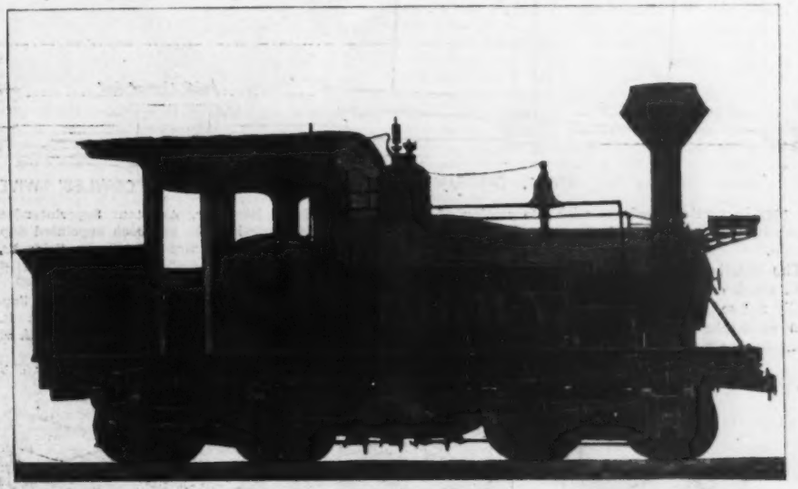


FIG. 2. COWLES' SWIVELING TRUCK LOCOMOTIVE ON PANTHER GAP RY., LIMESTONE, KY.

A NOVEL FLEXIBLE WHEEL-BASE LOCOMOTIVE.

We illustrate herewith a locomotive designed especially to run over the rough track and sharp curves of lumber roads, but which is claimed to have special advantages for operating over steep grades on switchbacks or on mountain divisions of ordinary railways. The locomotive resembles the Fairlie type in having driving wheels carried in a truck frame. It has only one pair of cylinders, located at the middle of the engine and rigidly attached to the frame, thus avoiding

trouble from movable joints in the steam pipes. Each driving truck is free to swivel about the main frame on a center pin, like the trucks on an ordinary car, and the chief peculiarity of the locomotive is in the mechanism for transmitting motion from the cylinders to the driving wheels.

This can be best understood from the accompanying diagram, Fig. 1. The main driving axle in each truck is tubular, its interior diameter being sufficiently large to permit a second axle to be placed within it. The main rods from the crosshead drive this interior axle by means of crank pins on its ends. The interior axle is joined to the tubular axle at its center by a universal joint, and hence, while the interior axle can "wobble" in the tubular one, the rotation of the former forces the latter to rotate with it. This tubular axle carries an annular crank from which the front and back drivers of the truck are driven by parallel rods.

The main crank shaft is kept square with the engine frame by means of bearings outside the cranks, connected to the main frame. It is made to vary in vertical position with the motion of the truck by means of rock shaft connections with the frame.

The details of the engine have been worked out with much care and ingenuity, and the machine is really not so complicated in its design and construction as might at first appear. Another arrangement for connecting rigid cylinders with swiveling

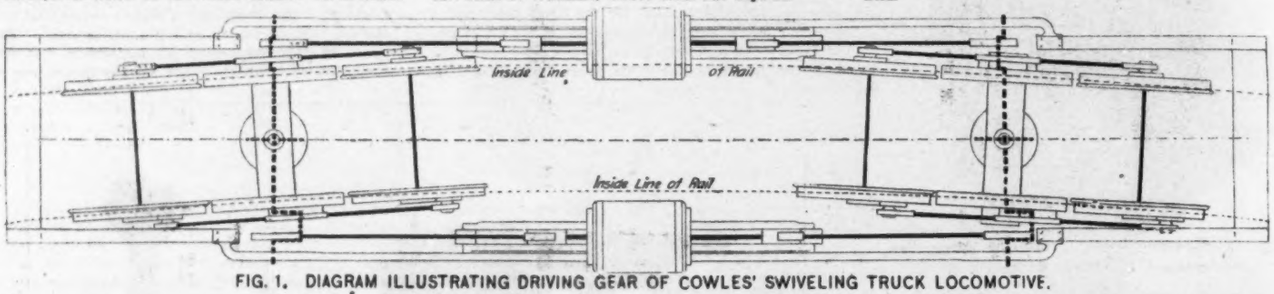


FIG. 1. DIAGRAM ILLUSTRATING DRIVING GEAR OF COWLES' SWIVELING TRUCK LOCOMOTIVE.

driving wheels was shown in the Johnstone double steam truck engine for the Mexican Central Ry. in our issue of Jan. 5.

Fig. 2 is reproduced from a photograph of the first locomotive built of the Cowles type. A locomotive similar to this, but weighing 8 tons, with a total wheel base of 16 ft., is claimed to have hauled a train of four empties weighing 16,000 lbs. up a grade of 11.4% (600 ft. per mile) and around curves of 50 ft. radius, having a grade of 450 ft. per mile, at a speed of 12 miles per hour. On reasonably straight track it is claimed to have run 25 miles per hour on a 16-lb. rail. It is stated that this locomotive runs with remarkable smoothness and little wear over very rough track. Fig. 3 is a drawing of a heavy 12-wheel locomotive of this type, with weight all on the driving wheels.

The inventor of this novel type of locomotive is Mr. E. P. Cowles, of New Decatur, Ala., from whom any further information may be obtained.

The validity of the water-works bonds issued by the city of Athens, Ga., for works, has been established by the highest court of the state. An injunction, probably in the interests of the local water company, was recently secured, to prevent the issuance of the bonds, on the ground that the election at which they were voted was illegal. The bonds have been sold. The details of the contention between the city and company were given in our issue of Jan. 5, 1893.

PERSONALS.

Gen. James C. Duane, has been re-elected President of the Aqueduct Commission, New York, N. Y.

Mr. James E. Parsons, Chief Engineer of the West Virginia Central & Pittsburg R. R., died in Cumberland, Md., Jan. 29.

Mr. Michael Rickard has been reappointed as a member of the New York Railroad Commission, his term of office being five years.

Mr. George H. Pegram has been appointed Chief Engineer of the Union Pacific Ry., with headquarters at Omaha, Neb., vice the late Mr. E. C. Smeed.

Mr. James K. Wilkes, City Engineer of Willimantic, Conn., has resigned to take charge of the construction of a sewerage system at New Rochelle, N. Y.

Mr. Ira B. Mills has been appointed a member of the Minnesota Railroad and Warehouse Commission, vice Mr. John P. Williams, whose term has expired.

Mr. William Renshaw, Assistant Superintendent of the Illinois Central R. R., has been appointed Superintendent of Machinery, vice Mr. Henry Schlacks, resigned.

Mr. W. F. Pascoe has resigned his position as Superintendent of Bridges of the Lehigh Valley R. R., to accept the management of the National Switch & Signal Co., Easton, Pa.

Mr. Benjamin Norton, formerly Vice-President of the Long Island R. R., has been elected President of the Atlantic Avenue R. R., of Brooklyn, N. Y., vice Mr. William Richardson, resigned.

Mr. Louis H. Evans, M. Am. Soc. C. E., has had his official position enlarged, so that he is now engineer of the Chicago, Galena and Wisconsin divisions of the Chicago & Northwestern R. R., with headquarters at Chicago.

Mr. J. B. Berry has been appointed Chief Engineer of the Fremont, Elkhorn & Missouri Valley R. R., with headquarters at Omaha, Neb. Mr. Berry has been connected with the Chicago & Northwestern R. R. for about 20 years.

Mr. Edgar Van Etten, Superintendent of the Rome, Watertown & Ogdensburg R. R., has been appointed General Superintendent of the New York Central & Hudson River R. R., with headquarters in New York, vice Mr. Theodore Voorhees, resigned.

Mr. W. T. Small, formerly Superintendent of Motive Power, of the Northern Pacific R. R., has been appointed Superintendent of Motive Power of the Buffalo, Rochester & Pittsburg R. R., with headquarters at Rochester, N. Y., vice Mr. Alonzo Dolbeer, resigned.

Mr. E. G. Russell, Superintendent of the western lines of the Illinois Central R. R., has been appointed Superintendent of the Rome, Watertown & Ogdensburg R. R., vice Mr. Van Etten, appointed General Superintendent of the New York Central & Hudson River R. R.

Mr. Dankmar Adler, member of the firm of Adler & Sullivan, architects, Chicago, Ill., has resigned the position of secretary of the American Institute of Architects, and Mr. Alfred Stone, of Providence, R. I., has been appointed by the directors to take his place during the current year.

Mr. David Hardenbergh, civil engineer, who died at Lone Rock, Wis., Jan. 27, was in early life engaged on the New York & Erie, the Ohio & Mississippi, and other railways. Later he was in the employment of the Chicago, Milwaukee & St. Paul R. R., engaged on its lines in Dakota and Iowa.

Mr. Harry J. Lewis has resigned his position with the Keystone Bridge Co., Pittsburg, Pa., and has opened an office in the "Times" Building, Pittsburg, for a general engineering business, particularly in the design, construction, and maintenance of bridges, buildings, and general structural work. During the past nine years Mr. Lewis has been engaged with the Wrought Iron Bridge Co., Canton, O., the Columbus Bridge Co., Columbus, O., and the Keystone Bridge Co., Pittsburg, Pa., with work in the office, shop and field.

Prof. Arthur T. Woods, formerly Professor of Mechanical Engineering at the Illinois State University and later Professor of Dynamic Engineering at Washington University, St. Louis, Mo., died of typhoid fever at Chicago, Feb. 7. He was about 34 years of age. He entered the United States Naval Academy, at Annapolis, as cadet engineer, in 1876, and was graduated in 1882. He resigned from the navy in July, 1887, with the rank of Assistant Engineer, and his most important work has been in civil life. He resigned his appointment at Washington University in August, 1892, to accept a position on the editorial staff of the "Railroad Gazette."

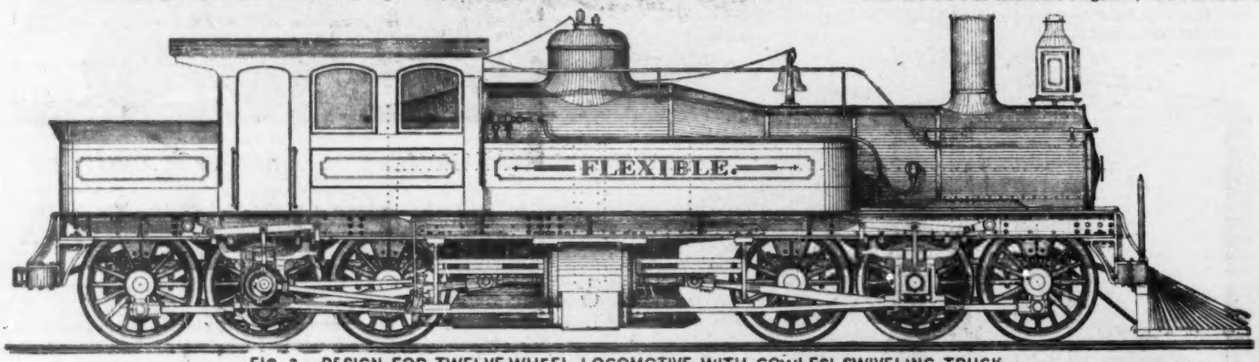


FIG. 3. DESIGN FOR TWELVE-WHEEL LOCOMOTIVE WITH COWLES' SWIVELING TRUCK.

The several departments of the Philadelphia & Reading R. R. have been reorganized, and the positions are now held as follows: President, A. A. McLeod; First Vice-President, Theodore Voorhees, in charge of the Operating Department; Second Vice-President, Charles G. Eddy, in charge of the Traffic Department. In the Operating Department the officers are as follows: Mr. I. A. Sweigard, General Manager; Mr. C. M. Lawler, General Superintendent, Main Line Division; Mr. Rollin H. Wilbur, General Superintendent, Eastern Division; Mr. T. H. Fennell, General Superintendent, Northern Division, vice Mr. William Stevenson, resigned; Mr. John Gordon, General Manager, Lehigh Valley Transportation Co.

NEW PUBLICATIONS.

ATMOSPHERIC RESISTANCE, and Its Relation to the Speed of Railway Trains. By Frederick U. Adams. Tribune Office, Chicago. Small, 4vo; pp. 80; 33 cuts.

Though a trade publication in the sense of being prepared to advocate the use of certain patents for decreasing the air resistance of trains, this is a book which deserves respectful consideration on its merits.

since it is a very handsome and complete presentation of the subject, from the writer's point of view, which he states and defends in detail by scientific arguments. In part we agree with the author and in part disagree with him, but as the subject is one of general interest we in effect review the book upon another page in an editorial dealing with the general question.

REPORT OF THE RAILROAD COMMISSION OF THE STATE OF CONNECTICUT, for the year ending June 30, 1892. Pub. Doc.; 8vo, cloth; pp. 333, appendix pp. 97; map.

The consolidation of the few remaining independent corporations with one of the two companies controlling nearly the whole railway mileage of the state is the most noticeable point brought out in the report. The end of the year 1892 finds 1,006.16 miles of railroad controlled by five companies. The New York, New Haven & Hartford controls 598.43 miles, or 59.48%; the New York & New England, 282.23 miles, or 28.05%; the Philadelphia, Reading & New England, 67.25 miles; the Central Vermont, 56 miles, while the South Manchester still maintains its separate organization, and owns and operates its 2.25 miles of road. Of the 1,088.60 miles operated, the New York, New Haven & Hartford R. R. Co., controls 851.67 miles, and the New York & New England R. R. Co., including the Meriden, Waterbury & Connecticut River R. R., controls 538.36 miles. The Connecticut River R. R. and leased lines, which at this writing are operated by the New York, New Haven & Hartford R. R. Co., under a temporary arrangement, are not included in these figures.

REPORT UPON WHAT WOULD BE JUST AND EQUITABLE RATES OF FREIGHTS AND FARES FOR THE RAILROADS OF CALIFORNIA. Made to the California State Railroad Commissioners, by Richard Price Morgan. Pub. Doc.; 8vo, paper; pp. 60; numerous tables and diagrams.

The contents of this report are quite clearly indicated by the title. Aside from the large mass of tabular matter relating to existing rates, the principal interest attaches to the discussion of the physical conditions and characteristics of the various railways operated in the state. The important part which the cost of fuel plays in railway operating expenses is clearly shown by the figures given for this item by the larger roads. The principal fuel used is coal; a small proportion only being wood. With minor exceptions the cost of wood is fully equivalent to the cost of coal, being from $2.75 to $6.00 a cord, delivered on the locomotive tenders The actual average cost of the coal used by the Southern Pacific Co. on its California lines is $6.40 per ton, delivered on the tenders, which for the year 1891 was $1,156 per mile of road. For the San Francisco & Northern Pacific R. R. Co., the cost of coal is $7.25 per ton, and for the Atchison, Topeka & Santa Fe lines $7.75 per ton. The average cost of coal per ton for railways in Southern California is $7.80, and in exceptional cases $9.00. A comparison with the cost of coal on railways in other sections of the country shows the importance of this item of expense in the operation of California roads. For railways in the states east of Chicago, with the exception of the New England states, the average cost of coal will probably not exceed $1.50 per ton, while for certain roads it is much less. The slack burned by the Philadelphia & Reading R. R. is stated to cost only 30 cts. per ton. In Illinois the cost of coal runs from 60 cts. to $2.73 per ton, and will average about $1.25 per ton.

TRADE PUBLICATIONS.

PUMPING ENGINES.—Holly Mfg. Co., Lockport, N. Y. 16mo, pp. 32.

This is mainly a list of engines built by the company, with the capacity of each. Since the first Gaskill high duty engine of 1882, 183 high duty engines have been built, with a total daily capacity of 969,500,000 gallons, and 249 engines of other types, making a total of 432 engines, of 1,449,620,000 gallons daily capacity, and representing about 47,350 HP.

DIRECT STEAM SYSTEMS OF CAR HEATING. Consolidated Car Heating Co., Albany, N. Y. Pamph. 8vo, pp. 24.

Part VI. of this company's catalogue describes the systems of direct steam heating which it offers. It is of interest to note that of the 4,141 car heating equipments which the company has turned out, 2,489 were for direct steam. All the direct systems offered dispense with thermostatic traps and avoid the freezing of the drip resulting from the water of condensation by heating it by contact with the main steam casting of the train pipe. The graduating valve for admitting steam to the car, described in the paper by Mr. A. M. Waitt, published in our issue of Sept. 29, 1892, is one of the appliances for use with direct steam which the Consolidated Co. offers. Among the novelties in the use of direct steam which are described in the catalogue are a direct steam storage system in which acetate of soda solution is used to store the heat instead of brine, a direct steam return system in which an ejector on the tender sucks the condensed water back through the return line, and a special system for heating fruit cars and other freight cars carrying perishable products in which the temperature in the car is automatically maintained between 45° and 55°.

SOCIETY PROCEEDINGS.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Feb. 1, Mr. J. W. Schaub read a paper on "The Detroit Union Depot Viaduct." The paper covered the full details of the design and construction of the viaduct, and was fully illustrated by drawings and photographs. For the next meeting, on Feb. 15, a paper by Mr. O. W. Ferguson on "Precise Leveling—Its Methods and Its Results," was announced.

Arthur Thacher, Secy.

IOWA SOCIETY OF ENGINEERS AND SURVEYORS.—The annual session was held at Des Moines, Jan. 18-19. The main subject considered was that of good roads, and several papers on this subject were read and discussed. Arrangements were made to co-operate with the Iowa Road Improvement Association. The engineers ask that the office of county surveyor be filled by competent engineers, and the duties increased by including the supervision of bridge work and road work in general in the country. Also that there be an examining commission to determine the competency of such officials.

ENGINEERING ASSOCIATION OF THE SOUTH.—The January meeting was held at Nashville, Tenn., Jan. 12; Maj. E. C. Lewis, presiding. Mr. Hunter McDonald, who had been appointed to prepare a memorial on the late Col. R. C. Morris, Chief Engineer of the Nashville, Chattanooga & St. Louis Ry., submitted the memorial, which was accepted and ordered to be printed.

Maj. W. F. Foster presented a description of the development of the water-power at Estill Springs, Tenn. At this point Elk River makes a bend, returning on itself after flowing several miles, the neck of land between the two portions being only 300 ft. across, with a difference of elevation of 12 ft., which is supplemented by a masonry dam raising the water above the bend an additional 12 ft. Across the neck of land a canal is cut, which provides for the fore-bay, the wheel-pits and the tail-race. The power-house of the mills that are to be driven by the power is placed over the wheel-pits. The dam is 300 ft. long between abutments, 5 ft. wide on the crest, is trapezoidal in cross-section, vertical on the up-stream side, and battered 6 ins. per ft. on the down-stream side. It is bedded throughout on solid rock. The masonry is heavy, random, coursed work, laid throughout in hydraulic cement mortar, with a portion of the down-stream stones in each course doweled to the course below.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The thirteenth annual meeting was held Jan. 17, President Alfred E. Hunt in the chair. The report of the treasurer showed that the receipts for the past year were $2,459; expenditures, $2,465; balance on hand, $240. The report of the secretary gave the present membership as 426. The address of the retiring president was then read, and the following officers were elected for the ensuing year: President, Max J. Becker; Vice-President, Thos. H. Johnson; Directors, Walter E. Koch and Emil Swensson; Treasurer, A. E. Frost; Secretary, R. N. Clark.

At the annual meeting of the Chemical Section on Jan. 24, Prof. Francis C. Phillips in the chair, the following officers were elected: Chairman, Joseph H. Eastwick; Vice-Chairman, Fred. Crabtree; Secretary, James O. Handy; Additional Directors, James Camp and George Faunce. Prof. F. C. Phillips, the retiring chairman, delivered an address, in which he referred at length to the giving of expert evidence before the courts. He deprecated the disrepute into which such evidence was sometimes thrown by the too great zeal of chemical experts to make out a strong case for the clients by whom they were employed. Such zeal might often lead to the suppression of certain facts and undue emphasizing of others. The secretary, Mr. Jas. O. Handy, then exhibited a large number of results obtained by several members in investigating the determination of sulphur in pig iron. The effects of hydrochloric acid of different strengths and temperatures, when used as a solvent in the evolution method, were fully shown. Acid of 3 parts acid to 1 part water, and temperature 90°, gave the highest results obtainable by the evolution method, and solution took place most rapidly. All these results in sulphur determination in pig iron by the evolution method were still from 14% to 34% lower than results from the aqua regia method. Mr. F. Crabtree said that vanadium had caused especially low sulphur determinations when present in pig iron made in Missouri.

AMERICAN INSTITUTE OF MINING ENGINEERS.—The 64th meeting (22d annual meeting) will be held at Montreal, Canada, beginning on the evening of Feb. 21. The sessions will be held at McGill University. The Mining Society of Nova Scotia, the Asbestos Club, the General Mining Association of the Province of Quebec, and the Provincial Mining Association of Ontario, are expected to hold meetings, including a general mining conference, in Montreal, during the week of this meeting.

The following programme is provisionally announced: Feb. 21, formal opening and reception in Windsor Hall, with address of welcome from Lord Stanley, Governor-General of Canada, and others; Feb. 22, sessions in the morning and afternoon, and a visit to the houses of the Montreal and St. George's snowshoe clubs in the evening; Feb. 23, in the morning, a session of the Institute; in the afternoon, the Institute will take part with other societies in a session of the general mining conference; in the evening there will be the formal opening of the new engineering buildings at McGill University; Feb. 24, in the morning continued joint session of the mining conference; excursions in the afternoon, and in the evening a carnival, given in honor of visiting members and ladies by the Victoria Skating Club; Feb. 25, excursion to Radnor Forges, Que., by special train, visiting the works of the Canadian Iron Furnace Co. (among the oldest on the continent, having made shipments to France in the 16th century); visiting bog-and-lake-ore deposits, charcoal kilns and lumber camps.

The following papers have been announced: "Phosphate Mines of Canada," Henry B. Small; "Note on Anthracite Coal-Apples from Pennsylvania," W. S. Gresley; "Reduction Works of the Mount Stewart Lead and Silver Mining Co., Leadville, New South Wales," F. M. Drake; "Mineral Resources of Southeastern Alaska," G. W. Garside; "The Cause of Faulting," John A. Church; "A Variable-Speed Pulley," H. C. Spaulding; "A New Form of Furnace for Roasting and Oxidizing Ores," W. P. Blake; "The Big Stone Gap Coal Fields," James M. Hodge; "Mineral Deposits of Southwest Wisconsin," W. P. Blake; "Separation of Blende from Pyrites: A New Metallurgical Industry," W. P. Blake; "Titaniferous Ores in the Blast Furnace," Auguste J. Rossi; "The Biwabik Iron Mine," H. V. Winchell and John T. Jones; "An Investigation of Coals for Making Coke in the Semet-Solvay Ovens, with the Recovery of Ammonia and Tar, and Remarks on the Commercial Sources of Ammonia," J. D. Pennock; "Manufacture of Metallic Manganese by a New Method," F. Lynwood Garrison; "Notes on Emmerton's Method for the Determination of Phosphorus," H. C. Babbitt; "Notes on the Geology of the Half Moon Mine, Pioche, Nevada," E. A. Wiltsee; "Method of Plumbing a shaft," A. Neustaedter.

COMING TECHNICAL MEETINGS.

WISCONSIN POLYTECHNIC SOCIETY.
Feb. 13, Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
Feb. 13, Secy., Waterman Stone, Baird Building.
DENVER SOCIETY OF CIVIL ENGINEERS.
Feb. 14, Secy., F. E. King, Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
Feb. 14, S. W. Spear, E. Buffalo, N. Y., Iron Works.
NORTHWESTERN SOCIETY OF ENGINEERS.
Feb. 14, Secy., D. W. McMorris, Burke Block, Seattle, Wash.
NORTHWEST RAILROAD CLUB.
Feb. 14, Union Station, St. Paul. Secy., W. D. Crosman.
ENGINEERS' CLUB OF ST. LOUIS.
Feb. 15, Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Feb. 15, Secy., F. Collingwood, 127 East 23d St., New York.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Feb. 15, Secy., S. E. Tinkham, 36 Broomfield St.
NEW YORK RAILROAD CLUB.
Feb. 16, Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Feb. 16, Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Feb. 16, Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Feb. 17, 201 Washington Building.
ENGINEERS' CLUB OF PHILADELPHIA.
Feb. 18, 1122 Girard St., Secy., L. F. Rondinella.
SWEDISH ENGINEERS' CLUB.
Feb. 18, Secy., P. Valentine, At 231 Union St., Brook'yn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago Secy., John Ericson.
WESTERN RAILWAY CLUB.
Feb. 21, Secy., C. F. Street, Rookery Building, Chicago.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Feb. 21, Secy., R. H. Clark, Pittsburg.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21, etc., Annual meeting, Montreal, Que. Secy., R. W. Raymond, 6 Burling Slip, New York, N. Y.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Feb. 22, Annual meeting. Secy., J. H. Schick, Roanoke, Va
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Feb. 24, Secy., C. H. McLeod, Montreal, P. Q.
WESTERN SOCIETY OF ENGINEERS.
March 1, Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago
ENGINEERS' CLUB OF MINNEAPOLIS.
March 2, Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
March 3, Secy., E. K. Smoot. 808 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
March 3, Secy., O. Von Geldern, 719 Market St., San Francisco.
MONTANA SOCIETY OF CIVIL ENGINEERS.
March 4, Secy., F. D. Jones, Helena.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
March 6, Secy., C. L. Annas, City Engineer's Office.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
March 7, Secy., Chas. S. Howe, Case School.
ENGINEERS' SOCIETY OF PHOENIXVILLE.
March 7, Secy., W. Halfbarton.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
March 8, Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
March 8, Secy., F. M. Curtis, O. C. R. R., Boston.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
March 9, Secy., Edward Mead, Norton Building
ENGINEERING ASSOCIATION OF THE SOUTH.
March 9, Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
March 10, Secy., D. W. Meeker, St. Paul.
CENTRAL RAILWAY CLUB.
March 22, Secy., S. W. Spear, Buffalo, N. Y.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20, Atlanta, Ga., Secy., F. A. Charlot, Macon, Ga.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

Chicago Office: Monadnock Building.
F. A. PECKHAM.....MANAGER

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The use of meters at Detroit, Mich., shows some remarkable results, which will be given more fully next week. It has effected a reduction of the daily per capita consumption of water from 204 gallons in 1888 to 140 gallons in 1892, about 31%, and has so reduced the pumping expenses as to make the operating expenses for 1892 actually $2,251 less than for 1888, notwithstanding an increase in population estimated at 46,000, and an increase in families supplied from 36,863 in 1888 to 46,400. While the population increased over 40% from 1888 to 1892, the total yearly consumption decreased nearly 15%. Mr. L. N. Case, Secretary of the Detroit Water Board, estimates that in the past four years the meters introduced have saved, in pumping expenses and interest on enlargments of the works, otherwise necessary, about $235,000. In addition an ever increasing extravagant waste, restrained only by lack of capacity of the works, has been stopped, and the per capita consumption has for four years been going steadily downward, instead of upward. Until the consumption is reduced to at least 100 gallons per capita the water commissioners of Detroit, it would seem, cannot begin to rest contented with the results of their efforts to save water, for as shown in our issue of Jan. 16, 1892, of 39 of the 50 largest cities of the United States, excluding Detroit, the daily water consumption of 31 was below 140, and of 21 below 100 gallons per capita, while 14 of these cities had a consumption of only 75 gallons, or less, and five were below 50 gallons. More conclusive evidence that meters are the proper solution for most of the difficulties from scant water supply could hardly be.

The plans for what is now frankly called the "North Pole Expedition" of Civil Engineer R. E. Peary, U. S. N., are now announced with some definiteness, and seem admirably calculated to achieve that end, if possible, without too great risk and hardship; or, if not, to get as near the pole as is possible. Mr. Peary proposes to leave for Greenland early in May, by the same steamer "Kite" which carried him on his former expedition, and to land at his old winter station on McCormick's Bay (latitude about 77° 40' N.) about June 1. Here Mr. Peary will cache a liberal supply of provisions, but push on at once with his party, as soon as dog trains can be made up, to Northern Greenland, 82° to 83° N., where he will establish a permanent camp for the winter. Musk ox and some other game exists in abundance in this region, and will furnish ample food supply.

Here during the summer there is open water, which in winter freezes over, and while it remains solid is fairly smooth, and of course is soon covered deep with snow. Over this ice and snow Mr. Peary proposes to push still further north during the winter night as far as he can with safety. The most northerly land as yet discovered is Cape Robert Lincoln, about 83° 30', whence it is 6° 30', or some 450 miles, in an air line to the pole. It is reasonable to suppose, however, that some land will be discovered still further north on which a camp can be established, if necessary; or it may prove possible to push ahead over the winter ice for the entire 500 miles or so between the pole and his Greenland camp, during the first winter.

Mr. Peary's purpose, as we understand it, is to take no chances, other than those incident to all exploratory expeditions in unknown regions, but to rely exclusively on the easy method of travel over ice and snow, of whose practical possibilities he may be said to be the discoverer, and which he has certainly demonstrated to be vastly ahead of all methods of Arctic travel heretofore used. Were he making another expedition in ships his attempt might justly be regarded as foolhardy rashness; but having made successfully one such trip of 500 or more miles over unknown ground, and gone safely through terrible storms by the simple expedient of burrowing in the snow, the assumption certainly seems reasonable that he may be able to go 500 more miles over a similar surface in the same way and in the same time, and thus reach the Ultima Thule of Arctic exploration.

Assuming that Mr. Peary goes no further than he can certainly return before the ice breaks without establishing caches of provisions, we fail to see why he may not feel his way from point to point with as much safety as explorers elsewhere; and perhaps discover other land on which he can travel long distances. The most serious danger which he fears is that a certain kind of rabies develops among the dogs during the long winter night, which is not contagious, but which does kill off many dogs, and disposes the rest to snap and bite. Mrs. Peary will not accompany this expedition, the expenses of which are borne wholly by Mr. Peary himself, out of the proceeds of his lectures. If good wishes are any aid to him, he will have plenty of them; and whether we approve or not of taking the risks inseparable from such an exploration, we must all admire the pluck of those who brave them, and the intelligent judgment which has so far so greatly reduced them.

The Austrian State Railway Co. distributes a time-table that has in it some features worthy of note by railway managers on this side of the Atlantic. This particular time-table is in the form of a small, thin book of convenient pocket size, and refers to through or express service only. On the left-hand page is the time-table proper, giving the chief stations and the time of arrival and departure of trains at each, and indicating the various routes between the initial points. The direction of trains is made clear by long arrows pointing up and down the sides of the page. The opposite page gives the rate of fare for first and second-class travel, and miscellaneous information regarding the several routes.

But the one feature especially recognized by every stranger traveling on these lines, as relieving him from a deal of mystification and trouble, is a route-map. This map is printed in a light red ink across the two pages and under the printed time-table, etc., in broad lines, with the initial points referred to in that particular time-table and all main connecting lines with their chief termini plainly lettered upon it. For example, if the time-table covers a through trip between Vienna and London, these cities form the extremities of the map and branch lines and connecting stations are shown for Munich, Mayence, Brussels, etc., and the Channel routes are indicated by dotted lines extending to the English coast from Calais, Ostend, Vleissingen and Amsterdam. This plan is followed for each separate time-table, with excellent practical results—to the traveler, as we know by experience. These maps are of the simplest character, and evidently very cheap in execution, as nothing but the main stations and connecting lines are shown: and that is really all that is wanted; but it is very much wanted by one unfamiliar with the general geography of the region traveled. In the United States our existing time-tables are often a puzzler to the old traveler, familiar with every chief city, when some new route is to be taken and junctions made with other lines. Our railway managers could much improve upon the Austrian plan in execution, and the extra expense of this map, placed just where it is most wanted, would be more than offset by the thanks of the traveling public. It is worth trying. It may be mentioned in this connection that some of the Argentine railways print across their advertised time-tables a map of the line in red, with the names of the stations printed on, thus making it very easy to follow the schedule of time.

ATMOSPHERIC TRAIN RESISTANCE.

On another page we notice briefly a recent very handsome publication by Mr. Frederick U. Adams, showing his grounds for believing that an important reduction in train resistance or increase in speed, with improved ventilation and some other accompanying advantages, can be obtained by using some improvements which he has patented, and which may be described in outline as the following:

1. The use of a pointed prow for the locomotive and the locomotive cab, and the complete encasement of the boiler and working parts in an outer shell, easily removed in part for access to the interior.

2. The removal of all projections and roughnesses from the body of the cars, the extension of the vestibules out to the plane of the top and sides of the car, and the enclosure of the truck space beneath the car by a platform just above the rails, connected by stiff spring curtains with the car body. A pointed rear to the rear car may also be added.

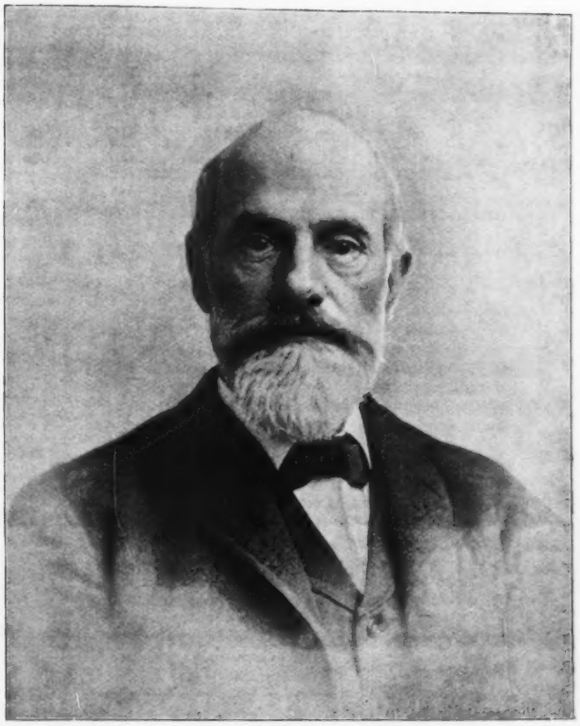
The general aim of the scheme is to minimize all side resistance, and to reduce the head and rear resistance by exposing only oblique surfaces to it.

The problem is attacked in a scientific spirit, and an effort is made to establish every claim by quotations from recognized authorities. He has incurred no small trouble and expense to present his case complete. It is but right that proposals and arguments thus presented should be considered in the same spirit. He makes a prima facie case. As it will be our duty to show that this case is in several ways very gravely defective, it is but common jutice to say what we can first in favor of his propositions, lest the hasty reader should make up his mind adversely without reading through the article.

Mr. Adam's propositions in regard to the locomotive are thoroughly reasonable upon their face, and, in our judgment, demand a fair trial. It would certainly be a contribution to science, and probably lead to an economic advance. There are some obvious and great disadvantages to offset the possible gains, but they are not insurmountable, nor do they seem likely to outweigh those gains, even after discounting heavily (as we shall see we must) Mr. Adam's estimate of those gains. Beyond doubt, the experiment should be made. There can be no great loss; there may be much gain.

The encasement of the locomotive as proposed promises two advantages. In respect to the probable decrease of air resistance, Mr. Adams does not seem to be aware that the experiment has been already tried in France with an enclosing case quite similar to his own, not quite so complete, but better shaped in being more pointed, and with all corners rounded with the result that about 10% of the train resistance appeared to be saved. Our recollection is that this percentage included the gain from encasing the spaces between the cars. The tests will be found fully described and illustrated in the "Annales des Ponts et Chaussees," of about six years ago. We are not aware that they were considered sufficiently decisive to encourage practical use of the device, but that fact in itself proves nothing.

We see no reason to doubt that something like this reduction in train resistance, perhaps more, possibly double that, may be obtained by carrying out Mr. Adams' idea. Why not find out? Some enterprising railway company needing to run fast trains should volunteer to do so, in consideration of free use of the device if approved.



Yours truly
Wm Murray

The second advantage to be gained by inclosing the locomotive is the still more important one of protection against radiation. To run locomotives at high speed through wintry air with exposed fire boxes, badly protected boilers (the radiation from which may be felt 20 ft. off) and absolutely naked cylinder ends is "not business." It may be said that the cylinder ends are not naked, being protected by a cover inclosing an air space; but here we wish to point out again a common error. While air is a very poor conductor of heat, it is almost transparent to radiated heat, as any one has had practically proven who has ridden in a fast train past piles of burning ties and felt the flash of heat from them as he passed, through 20 or 30 ft. of air and a pane of glass. Therefore, although a single sheet of paper in this air space might obstruct the radiation of heat so that the non-conducting properties of air would come into play, a wholly vacant air space between two excellent conductors lets heat radiate across it almost as freely as if it did not exist.

Some student in search of a subject for a thesis can do a useful work by a series of experiments on this point, showing the actual utility of this air space with and without some fibrous obstruction, when cylinders are exposed to blasts of air of varying speeds and temperatures. If properly made and presented, such an investigation would stand a very good chance of carrying off one of the annual prizes for theses which we offer, as it would be a real contribution to knowledge.

It was shown about ten years ago (see reports of Master Mechanics' Association) that the mere lagging of the fire-box sheets with asbestos or other like non-conductors resulted in a saving of about 10% in fuel, but the proposed complete encasement of fire-box, barrel, cylinders and all in an outer shell easily removed at any point should accomplish vastly more than any mere fire-box lagging, and probably in a better way. It should also, if properly made, protect the machinery from mud and dust somewhat, and add but little to weight and cost. Considering that such a shell would also be certain to decrease sensibly (if not materially) high-speed train resistance, we know of few more promising directions for hopeful experiment. Once determined for the locomotive, the expediency of experimenting with cars in the same way, where the possible gain is less important, could be better judged.

So much for the good points of Mr. Adams' claims; now for the bad points. On the details of his claims and computations he is gravely in error in many ways, a fact which is the less surprising because Mr. Adams frankly confesses that he is not an engineer. Five years ago he was detailed as a newspaper reporter to write up a proposal to build a locomotive with 16-ft. drivers to run from Chicago to New York in one hour! He made some startling computations of air resistance by the Smeaton formula, and there rested for three years. Two years ago he noticed the gusts of air between the platforms of a Colorado train, obtained such books of reference as he thought were necessary, made some calculations which astounded him, and speedily "the conviction was forced upon me that atmospheric resistance is the all-predominating factor in the total of train resistance." Then followed two years of further study, and at the end of it he wonders why the subject has been so generally ignored; why there are no reliable data about air resistance, and several other things.

The true answer to these doubts is that the subject has not been ignored to anything like the extent that he thinks. Dozens of men have made experiments that he has never heard of, and which show no such results as he claims. Thousands of long-headed and keen-eyed men have been quietly putting this and that together in watching train movement, and have observed no such great excess of train resistance in high winds as he attempts to establish. Hundreds, probably, have made sketches for pointed prows and the like, and finally abandoned them because further investigation discouraged the idea. The present writer, among others, has a complete set of sketches made in 1874-6, outlining almost every feature of Mr. Adams' plans, including locomotive case and pointed prow, smooth sides to cars and boxing in of the truck space, and so on. This does not impeach Mr. Adams' right to patent, because they were never more than an idea. He retained then and since the beliefs in favor of the idea expressed above, but he did not attempt to put the idea into practice, partly for lack of time and opportunity, but chiefly because experimental investigations of train resistance which he was then making proved beyond all cavil that there was much less to be gained than appeared.

For instance, Mr. Adams' whole argument is based upon the assumption that all the extra train resistance caused by high speed is caused by air resistance. He will find much, very much, in engineering literature to support this view; probably more in quantity than to support the opposite view. Yet it was long since shown experimentally to be wholly erroneous. If it were so, for example, the total velocity resistance in pounds (i. e., increase above the slow speed resistance) would be no greater for a train of box or gondola cars loaded with pig

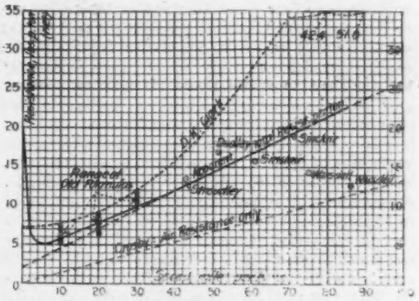


Diagram of Best Existing Records of High Speed Train Resistance.

iron than for the same cars empty. On the other hand, if there were no air resistance whatever, but the increase due to speed was caused by the greater oscillation and concussion in some way the resistance per ton would be the same whether the cars were loaded or empty, and the total velocity resistance of the whole train would increase directly with the load.

Experiment shows that neither the one nor the other of these is true, but that the truth lies betwixt and between them; i. e., about half the increase caused by velocity varies with the area exposed, regardless of weight, and about half varies directly with weight, the exposed bulk being constant. These proportions have not been accurately established, but the general fact that not all, nor nearly all, of the velocity resistance is caused by air resistance, is established beyond all possibility of dispute.

Again, the total resistance at high speeds is much better known than its elements; and this is greatly less than Mr. Adams computes. In our issue of June 9, 1892, we summarized very fully the best existing evidence as to the actual resistance of high-speed trains, and embodied it in the accompanying diagram reproduced from that issue. By the references in that article, if followed back until they end, all statements in this article can be checked; we cannot give the references over again. As the result of that investigation we suggested that the empirical formula $R = \frac{1}{4} V + 2$ agreed better with the mean of all facts so far as recorded as to the resistance of high-speed trains than any other for tons of 2,000 lbs., and we have seen no reason to change that opinion. This formula compares with D. K. Clark's and with Mr. Adams' as follows:

	Resistance in lbs. per ton of 2,000 lbs. by		
Speed m. per h.	Eng. News formula.	D. K. Clarke.	Adams est.
30	9.5	11.6	17.3
40	12.	15.2	26.8
50	14.5	19.7	39.6
60	17.	25.9	54.9
70	19.5	32.2	73.6
80	22.	40.2	....

(The Adams estimate quoted is for a train of 4 cars and engine, 250 tons.)

When we consider that all but 6 lbs. of the Adams estimate is allowed for air resistance, and only half of the resistance by the Engineering News formula, or thereabouts, is ascribed to air resistance, the discrepancy between the two is evident. At 70 miles per hour it is no less than as 9.8 to 67.6 lbs.

It must not be inferred from our citing this empirical formula that we then advanced it, or that we now advance it, as a finality. All that was or is claimed for it is that is agrees quite closely with the experimental evidence which now exists, and that any materially different formula cannot be reconciled with that evidence. Therefore, while it is highly desirable to obtain more evidence on the subject, the formula cited is entitled pro tem. to more credence than any other.

How then, if our statements are correct, has Mr. Adams gone so far astray? We can only briefly indicate this. He first starts with the old Smeaton air resistance formula (R per sq. ft., = .005 V^2 in miles per hour). That formula is very old, was never very well established, and has floated since chiefly on Smeaton's name and for lack of a better. It was put forward only for surfaces for use in windmill practice. The trend of modern evidence is that it is approximately correct only for such surfaces, and that for large solid bodies it often gives greatly too large results. Not satisfied with this, however, Mr. Adams finds in Trautwine's Pocket Book a chance remark about a single observation at Liverpool indicating that the resistance might be twice what Smeaton gives; and he draws from that what he calls the "Trautwine formula," showing just double as great resistance as Smeaton's, and proceeds to adopt thereafter what he calls a "compromise" formula, a mean of the Smeaton and Trautwine. But Mr. Trautwine never advanced a formula. He only expressed doubts about the Smeaton rule.

Similarly Mr. Adams refers to estimates of Messrs. Chanute and Bessemer to the effect that the velocity resistance of each succeeding car is about 40% of the front car, which probably is not far from true; but this is one of the strongest reasons why it is impossible to ascribe all the velocity resistance to air resistance. If a good part of the velocity resistance is due to oscillation and concussion, this should naturally result; but in respect to air resistance only, if any one will put their hand in front of the woodwork of any window or rear car end, they will see how very slight is the additional resistance arising there. This is due to the fact that the rear cars travel in the wake of the preceding ones, and have a mass of relatively dead air along their sides. With a high side-wind there is more effect from side resistance, but we are talking only of the general case.

Mr. Adams also presents figures of passenger coal consumption for nine months on one road only (C., B. & Q.), which appear to show "the largest passenger coal consumption in windy March and the smallest in placid August." If he will collect records covering six or eight complete years' experience with both passenger and freight trains on six or eight different roads, and construct a diagram from them comparing coal consumption with mean monthly temperatures and wind velocities, as the present writer did for this very purpose some 16 years ago, he will find that it is absolutely impossible to trace any noticeable effect of wind velocity on coal consumption, but that there is an amazingly delicate relation between coal consumption and mean monthly temperature, which follows very closely the general law of 1% increase in coal consumption for each 2° F. difference of temperature. Why this should be quite so large as it is, is hard to explain, but the fact is easily shown.

So we might go on with a number of other points in which Mr. Adams' lack of familiarity with the details of engineering practice and literature has led him astray. Thus, the Bessemer experiments, having been made with a "spring balance," are worthless as evidence. Some tall guessing must have been done in the readings. But we close, as we began, by saying that, after all the heavy allowances have been made which should be made, there still remains a prima facie residuum of sound practical common sense in his suggestions, which warrants and demands that the more promising of them should be put to the best of trial.

FUEL CONSUMPTION ON ELECTRIC AND STEAM RAILWAYS.

The description of the power station of the electric street railway at Little Rock, Ark., by Mr. B. J. Arnold, its designing engineer, which is completed in this issue, is a paper worth careful study, and one which gives some important figures bearing on questions which have been hotly disputed over by engineers.

We have heard a great deal, from those who ad-

vocate electricity as a panacea for all ills, concerning the advantages of electric traction on ordinary railways. The steam locomotive, say these wise ones, is a clumsy and wasteful machine. It adds a great amount of dead weight to the train, which is absolutely necessary to secure traction. Its boiler makes steam with an excessive consumption of fuel, and its cylinders do not use the steam economically to produce power. With electric traction, on the other hand, power can be generated at a central station by a power plant which will get the last possible ounce of work out of the fuel. Large boilers using cheap coal can generate steam with great economy, and compound or triple-expansion engines connected to condensers will generate power from this steam with maximum efficiency.

Of course the defects in this method of argument, which magnifies the losses of one system and omits to mention those of the other, have been often pointed out. But so great is the popular confidence in electricity and its possibilities that considerable time and money have been spent in investigating the feasibility of electric traction on steam railways, as a result of the extravagant claims which have been made for it. These investigations have been the basis, where any basis existed, for the stories which have been circulated concerning the adoption of electric traction by half a dozen of the great railway systems of the country.

But with all the claims which have been made for electric traction, very few figures have been published showing just what fuel efficiency is obtainable with it. The paper of Mr. Arnold is especially interesting because it gives these figures and gives them in such a shape that there is no room for doubt as to their substantial correctness. In the two months of July and August, 1892, 538 tons of fuel were burned under the power station boilers and 133,748 car miles were run on the railway. Thus, by division, we have at once the fuel consumed per car-mile (7.55 lbs.), and dividing again by the weight of the car, 5½ tons, we have the fuel consumption per ton mile at 1.373 lbs.

This is apparently a very good record for an electric street railway, and one which does credit to the designer of the station. It will be seen from the description that much pains was taken to secure high economy. The boilers are well planned and have a good draft, the engines are compound, with Corliss valve gear, and the plant is run condensing, which is far from being the rule in street railway power stations. Mr. Arnold estimates the coal consumption at 3.37 lbs. per I. HP. per hour, the electrical output being determined by averaging the reading of voltmeters and ammeters, and reasonable allowances being made for loss in engine, line shaft and dynamo. This may seem no very remarkable result when compared with the performance of pumping or marine engines, or even of the engines in New England textile mills; but it must be borne in mind that a street railway power station operates under loads which are extremely variable, not only from minute to minute, but also from hour to hour. The engines must be run most of the time very much underloaded. Add to this the fact that the station was run during this test on slack from the Arkansas coal mines, and it will certainly be admitted that the power generating portion of the plant is making a very good record.

Now let us see how this fuel expenditure of 1.373 lbs. required to remove a ton a mile on the Little Rock electric railway compares with the fuel consumed to move a ton a mile in ordinary railway service, the weight moved in each case being the total weight of the car and its load. The following figures are taken from the annual report of the Pennsylvania Railroad:

Pounds of Coal Burned per Car Mile on Pennsylvania Railroad.

	1888.		1889.	
Division:	Frt.	Pass.	Frt.	Pass.
Pennsylvania R. R...	5.27	12.58	5.23	12.92
U. R. Rs. of N. J....	4.69	14.95	4.74	14.91
Phila. & Erie.....	4.00	15.40	4.20	15.10
Average	4.65	14.31	4.72	14.31

Taking the weight of the average freight car with its load (averaging loaded and empty cars) at 21 tons and the weight of the average passenger car at 23 tons, we have an average coal consumption in the two years of 0.22 lb. per ton per mile in freight service, and 0.62 lbs. per mile in passenger service, or one-sixth and one-third, respectively, of the fuel consumed in moving a ton a mile on the Little Rock Electric Railway.

But in order to complete our comparison we must determine the average resistance to traction on the electric and on steam railways, and these figures are difficult to estimate with accuracy. The resistance per ton required to maintain an average speed on a level tangent track is certainly much more on the electric road than on the steam road, due chiefly to the dirty rails and small wheels, and to the smaller loads per square inch of journal, and the greater amount of dust and grit to which the street car journals are exposed. Experiments of Wellington, Emery and Wright on horse cars* showed an average resistance per ton on level tangents three to four times as great as the resistance to the movement of ordinary passenger and freight cars. To this is to be added the fact that the average grades on street roads are considerably heavier than on steam roads. It may be also argued that the electric road works at a disadvantage on account of its frequent stopping and starting; but this is largely offset in passenger service by the variations of speed. The ordinary passenger train, when running at 40 miles per hour, for example, requires nearly as much energy to raise its speed to 41 miles per hour as is required to bring it from rest to the ordinary street car speed of ten miles per hour. Again, the increased weight, larger wheels and better construction of the modern electric car ought to have somewhat reduced its coefficient of journal friction, compared with that of the old-fashioned horse car.

Taking all these things into consideration, it seems fair to conclude that the resistance per ton is not more than three times as great on the electric railway as it is in the average Pennsylvania Railroad service. On this assumption the coal consumed to do a given number of foot-pounds of work on the Little Rock Electric Ry. is about equal to that required to do the same work in hauling passenger cars on the Pennsylvania Railroad, and double that consumed in hauling freight cars on the same road.

Do those who expect to save fuel by substituting the electric motor, in its present stage of development, for the steam locomotive, find much encouragment in this? It will be seen that we have already made allowance for the different resistance of electric cars and those used on steam railways, also that we have given the steam locomotive no credit for the work expended in moving its own weight. It is claimed for electricity that, by attaching a motor directly to each car the dead weight of the locomotive can be eliminated; but this claim has not been generally admitted, and if it should be found necessary to place a single motor at the head of the train, little saving in weight can be made over that necessary with the steam locomotive.

How, then, can any material decrease in fuel consumption be expected by the substitution of electricity for steam in regular railway service? There seems no reason to expect any material gain in the efficiency of motors of large size over those now in use, and in fact, there is not much room for gain. The loss in transmission, in view of the greater distance and far larger quantity of power to be transmitted, must be considerably greater than that in street railway service. The gain, then, if material gain is to be made, must be in the generation of power, and the question is, can such a gain be expected? The increased load, compared with that in street railway service, will be some gain; but, on the other hand, the variations of load will increase with the increase in size of the train units, and it is the variations in load which prevent the engines of electric central stations from approaching the economy of engines working under steady load.

We can obtain a clear idea perhaps of the comparative efficiency of steam and electric traction by examining the losses in the Little Rock electric system. By actual measurement, the average electric horse power of the current generated at the station during the two months of the test was 226.52. Mr. Arnold estimates that there was a 10% loss in the dynamos, a 6½% loss in the line shaft, and a 10% loss in the friction of the engine, making the actual work done by the steam in the cylinder 286.55 I. HP., and the average fuel consumption per I. HP. hour 3.37 lbs. of coal. Now suppose we go farther and estimate the loss in transmission from the dynamos to the motor at 15%, and the loss in the motor itself and in the gears connecting it with the axle at 15%. If these assumptions are correct, only 58% of the power generated in the steam cylinder is actually applied to the propulsion of the car, and with 3.37 lbs. of coal per I. HP. hour, we have 5.81 lbs. of coal consumed per horse-power hour of energy exerted on the car. Tests showing the consumption of fuel by locomotives by horse power per hour are not very abundant. The best which we now recall are those made by Master Mechanics' Association Committee on compound locomotives (Eng. News, June 23-30, 1892). These showed a coal consumption per horse-power hour of 2.88 to 5.85 lbs. The average of all the tests, which were so made as to be a fair showing of average working in ordinary freight service, was about 4.33 lbs. per horse-power hour, when Braceville coal was used, and 3.42 lbs. when Pittsburg coal was used. These figures are based on the work actually done in hauling the train, measured by a dynamometer at the rear of the tender. The corresponding figures for coal burned per ton of train back of tender per mile were 0.116 lb. with Braceville coal, and 0.086 lb. with the Pittsburg coal.

It appears, then, that the locomotive is already able to produce power from coal with nearly as good economy as the stationary engines of an electric railway power station; and that the losses in converting the power into electric energy, transmitting the electrical current along the line, and converting back to mechanical work in the motors on the train, are greatly in excess of the losses which occur in the steam locomotive.

We are fully aware that the matter of loss or gain in fuel is by no means the strongest argument in favor of the electric system, as it is far from being the strongest argument against it. But so much has been said concerning the wonderful fuel economy of the electric railway that the general public has formed erroneous opinions on this subject. That the electric motor is far superior to steam traction on street railways is fully proved, the reason being that the steam locomotive is entirely unsuited to such slow speed, light traffic duty. But because the electric motor is in every respect superior for street service, it does not follow that it can compete with the steam locomotive in regular railway service, as the figures above given fully prove.

* See Trans. Am. Soc. C. E., vol. VIII., p. 21; vol. VII., p. 105; Jour. Assoc. Eng. Soc., vol. V., p. 88.

LETTERS TO THE EDITOR.

"FIXED LEAD."

Sir: Referring to a letter from Edwin Mitchell, on switch leads, in your issue of Jan. 12, 1893, and your remarks on the same, I would like to ask for an exact definition of "fixed lead." In case of a stub switch is it the distance from "headblock" to "frog point," or to the nearest end of the wing rail of the frog? Or what does Mr. Mitchell mean by "toe of frog" and "heel of switch?" Would it not be better in switch work always to figure from point of frog, as frogs are made of different lengths? Yours truly,

A. L. James.

London, Ont., Jan. 13, 1893.

(Switch work always does figure from point of frog, never from any other part of it. The "lead" is the distance from point of frog to the junction of the turn-out curve with the main line. In a stub switch this is divided into the "fixed lead" (often called lead only) terminating at the head-block, and the movable or switch-rail lead. In a split switch the "lead" extends from frog point to head-block, and the "fixed lead" terminates at the rear ends of the moyable points. The theoretical or ideal curve of the point switch lead as ordinarily put in extends considerably beyond the head-block.—Ed.)

THE NEW WATER-WORKS AT HAVANA, CUBA.

Sir: The Havana new water-works were inaugurated on Monday last, Jan. 23, that date having been chosen as being the birthday of the young King of Spain, Alfonso XIII. The ceremony took place with the assistance of the Captain-General and Archbishop, and in the presence of a numerous assembly.

A few lines of description of these works may be interesting to your readers.

The source of supply consists of a number of springs, about 400, which have been collected in a masonry basin at Vento, a point upon the Almendares River, about ten miles distant from Havana. As this basin is situated upon the opposite side of the river, a tunnel was built upon the "inverted siphon" plan, passing under the river. Within the tunnel two lines of one meter, or 40-in. cast iron pipe have been laid, which convey the water across the river. This work is very well executed, the tunnel showing no leakage, and the pipes being well laid. The pipes are connected with a masonry aqueduct of a total sectional area of about 41.30 sq. ft. The area to the spring line of the arch, to which height the water is calculated to rise, is about 24.37 sq. ft., and the general fall 1 in 5,000. With these data the calculated velocity is 0.7666 m., or 30.16 ins. per second, and the delivery 104.10 cu. m. per minute, or, say 150,000 cu. m., or near 40,000,000 U. S. gallons per 24 hours. The aqueduct is about six miles long, and leads to the distributing reservoir at Palatino.

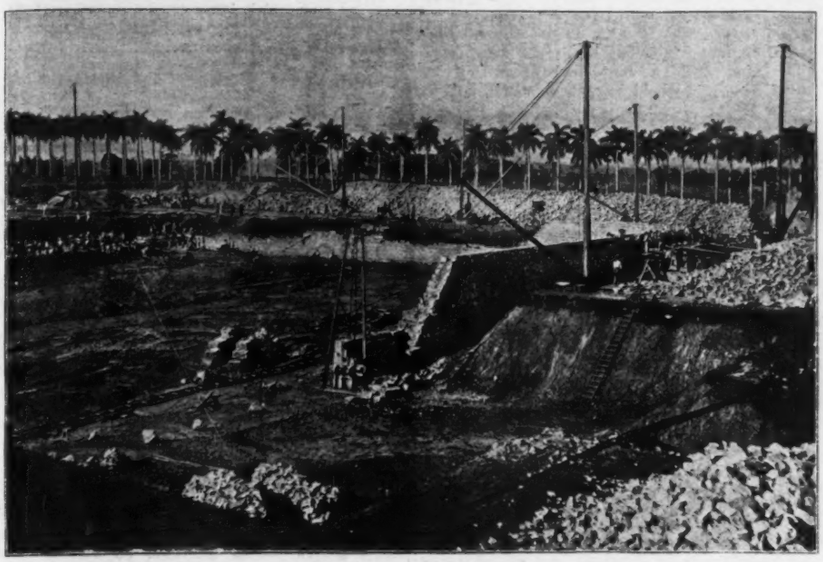


FIG. 1. DISTRIBUTING RESERVOIR OF THE NEW WATER-WORKS AT HAVANA, CUBA; CONSTRUCTION IN PROGRESS; Mr. E. Sherman Gould, M. Am. Soc. C. E., Constructing Engineer.

This work, with the exception of the Palatino reservoir, was commenced in 1861, and seems to have been carried on in a desultory way till lack of funds necessitated a total suspension. The engineer to whom is due the credit of the design and partial execution of the same, was Gen. Francisco de Albear, and the writer of these lines cannot let this opportunity pass without recording a tribute to the genius and ability of this distinguished engineer, who died in 1887, too soon to see and to direct the completion of his cherished project.

On Nov. 20, 1889, the contract for the completion of the work was awarded to Messrs. Runkle, Smith & Co., of New York. Work was commenced under this contract in March, 1890, the general manager and representative of the company being Mr. Richard Narganes, of Havana. Mr. E. Sherman Gould, M. Am. Soc. C. E., is the consulting engineer for the entire work, and executive engineer for the building of the Palatino reservoir. The laying of pipe is under the immediate charge of Sr. Ettore Simonetti. Maj. Joaquin Ruiz, of the Royal Spanish Engineers, is director of the work for the city of Havana, and Maj. Ricardo Seco, of the same corps, inspecting engineer for the Spanish bank, through which institution payments are made to the contractors. Col. Lino Sanchez, also of the Royal Corps of Engineers, acts in an advisory capacity to Major Ruiz, above named, who is the responsible director of the whole undertaking on the part of the city. The writer again arrests his narrative to tender his acknowledgments to the above named officers for courteous and amicable relations, both social and official.

The work already executed under the contract consists of the above named Palatino reservoir, which is double, and has a total capacity of about 16,000,000 U. S. gallons, or one day's supply for the city; and a system of cast iron mains and distribution pipes. The reservoir is to be covered, but the character of the cover, and even the question whether it should be covered at all, has been the subject of protracted discussion, and final plans for the cover have not yet been handed to the company's engineer. In the meantime, water is to be furnished through a direct service, without entering into the reservoirs.

The yardage of some of the principal classes of work executed in the reservoir up to Nov. 1, 1892, is as follows:

Excavation	111,500	cu. yds.
Concrete	8,850	" "
Rubble masonry	11,500	" "
Cut stone "	2,240	" "
Brick "	735	" "
Plastering	20,600	sq. yds.

Up to Jan. 1, 1893, about 23,500 bbls. of Portland cement had been used on this work, largely Gibb's English, special grinding. Latterly, over 1,000 bbls. of Atlas American Portland cement have been used.

Up to Jan. 1, 1893, over 86 miles of cast iron pipe had been laid, aggregating about 8,430 tons of 2,000 lbs., and requiring about 190 tons of lead for joints.

The service pipes laid are of wrought iron, according to specifications. Considerable trouble has been caused by the rapid oxidation of these in the street soil of Havana.

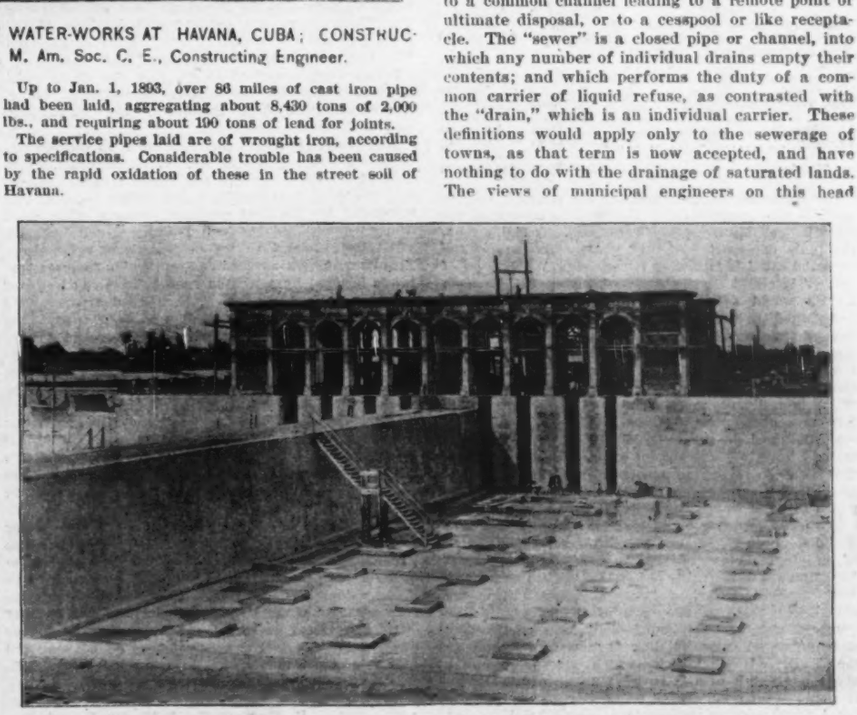


FIG. 2. INTERIOR OF NEW RESERVOIR AT HAVANA, CUBA, AND VIEW OF EFFLUENT GATE HOUSE

The interior of the reservoir during construction, as it appeared Jan. 24, 1892, is shown by the accompanying photograph (Fig. 1).

Another photograph (Fig. 2), taken Oct. 8, 1892, shows the interior of the west division of the reservoir, with concrete bases for roof pillars, the effluent gate-house, and the plastering on the concrete bottom of the reservoir.

A battery of Ludlow gates, operated by hand wheels at the ground level, is placed in the gatehouse.

Very faithfully yours,

E. S. G.

Havana, Cuba, Jan. 24, 1893.

THE EXACT DEFINITION OF "SEWER" AND "DRAIN."

Sir: I write to call your attention to a confusion in the definition of the word "sewer" that is seen in the laws and plumbing regulations of many cities. In the city of New York the house drain, for example, is supposed to be divided into two parts—the drain and the house sewer; in this city the plumbing regulations divide the drain into the parts known as the external and the internal house drain, reserving the word sewer for a drain common to several houses. It appears to me that the proper use of the word "sewer" would prevent us from speaking of a house drain as a sewer, that word implying that the drain is used in common by a number of houses or pieces of property.

The Public Health Act of England, of 1875, contains a number of definitions, and among these the word "sewer" is defined as distinguished from a drain as follows:

"Drain" means any drain of, and used for the drainage of one building only, or premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed.

"Sewer" includes sewers and drains of every description, except drains, to which the word "drain," interpreted as aforesaid applies, and except drains vested in and under the control of any authority having the management of roads, and not being a local authority under this Act.

If you will lend your influence to some exact definition of the word "sewer," I think it would be a help to municipal engineers and the profession in general.

Very truly yours,

Horace Andrews, City Engineer.

Albany, N. Y., Jan. 18, 1893.

(As applied to the sewerage of cities and towns only, but including the removal of rain water, a broad distinction between "drain" and "sewer" could be made as follows: A "drain" is a closed pipe or channel, usually of small dimensions, conveying the fluid refuse from individual premises to a common channel leading to a remote point of ultimate disposal, or to a cesspool or like receptacle. The "sewer" is a closed pipe or channel, into which any number of individual drains empty their contents; and which performs the duty of a common carrier of liquid refuse, as contrasted with the "drain," which is an individual carrier. These definitions would apply only to the sewerage of towns, as that term is now accepted, and have nothing to do with the drainage of saturated lands. The views of municipal engineers on this head would be welcome, and possibly lead to an exact definition that would be useful and acceptable to the profession generally.—Ed.)

FROM THE GREAT LAKES TO THE SEA.

Sir: In your issue of Jan. 5 I notice you say that the proposed ship canal from the Great Lakes to the sea will "never pass beyond the stage of press discussion," and other remarks which were evidently intended to discourage the scheme. It seems to me that so great an enterprise, and one that would result in so great a benefit to the entire North and Northwest, should not be so lightly set aside.

As stated in your editorial there has been no "intelligent estimate of cost," but all engineers who have looked the ground over agree that it is entirely feasible, and all say that it is only a question of money. Everything considered, it is more than probable that the route by way of Lake Ontario, Oswego, Troy and New York would be the most advantageous one. If water cannot be obtained at the Rome summit level in sufficient quantity, it can be taken from Lake Erie. The estimate for this route (or, as you rightly say, "guess") ranges all the way from $100,000,000 to $150,000,000. I have seen no estimate (except in your editorial) where it was given as "several hundred million." Even if it were to cost $200,000,000, I wish to present some figures which indicate that it would be a paying investment to the people, even at that enormous cost. The following table gives rates and distances, taken mostly from the Bureau of Statistics, report of 1891, with additions to date; and also some estimated rates that would probably prevail after the completion of the canal:

Article.	From.	To.	Miles.	Rate per m., cts. Mean.	Corrected.		Years averaged.
Iron ore	Marquette	Ohio ports	627	.23	to .12		10
" "	Escanaba	" "	602	.15	" .08		10
" "	Ashland	" "	770	.12	" .08		10
Coal	Buffalo	Milwaukee	805	.09	" .06		10
"	"	Escanaba	742	.07	" .07		10
"	"	Chicago	905	.08	" .06		10
"	"	Superior	1,010	.05	" .03		8
Wheat	Chicago	Buffalo	905	.086	" .056		10
"	"	New York	1,345		.17	(lake and canal)	10
"	"	" "	1,345		.25	(lake and rail)	10
"	"	" "	960		.52	(all rail)	10
"	"	" "	1,633		.05	(est. new canal)	
Mdse., lake	Buffalo	Chicago	905	1.0	" 3.5		1
Mdse., rail	New York	"	960	2.5	" .8		1

The "years averaged" in all cases end with 1892, and extend back for the number of years stated. The "lowest mean" was generally 1891, but in one case 1890, and in one case 1889.

In the above table I have allowed a total delay for locks of 36 hours, and added an equipment mileage, at 8 miles per hour, to the total distance traveled. With these rates and distances I have computed the following amounts that would be saved by the construction of the proposed canal:

Commodities.	Amount in tons.	Amount saved.
Wheat (including flour), half by rail to N. Y., rest by Erie Canal.	5,600,000	$11,126,800
Wheat (handling at Buffalo 12 cts. per ton)		672,000
Wheat (elevator charges ⅛ ct. per bu.)		700,000
Iron ore (to coast ports)	2,000,000	3,900,000
Coal	1,000,000	1,350,000
Merchandise	1,000,000	4,528,000
Lumber	1,000,000	1,630,000
Totals	10,000,000	$23,906,800

The commerce here claimed for the canal, it will be seen, is very conservative. The total commerce of the lakes is probably about 40,000,000 tons. To claim, then, that only one-quarter of this would make use of the proposed canal is "drawing it very mild." The item of lumber is added on the supposition that the Western forests would enter into competition with Southern and Canadian lumber at New York; whereas at the present time this is impossible. To the objection that many miles of canal must be operated at low speeds, I would say, pave the bottom of the canal, and thereby enable all boats to make at least 8 miles per hour, which is really the most economical speed for towing. Any rate above this is usually gained by a loss of coal consumed per ton-mile. In all of the above estimates I have left entirely out of consideration the fact that vessels, except to northern coast points, could go beyond New York without breaking bulk; a fact which in itself is nearly worth the cost of the canal.

The point formerly made that lake vessels were not suited to ocean travel has very little force now, as all of the better class of vessels are now being built for a draught of 20 ft. instead of 14 ft. They are, therefore, much stronger, and nearly all of them are abundantly able to take care of themselves in the roughest waters. This is especially true of the new style of vessel, now building at Superior, known as the McDougal Whaleback, which already comprise about one-eighth of the entire tonnage of the lakes. It would seem then, for all of these reasons, that the canal would save to the people at least $23,900,000. At 4% interest this would justify an expenditure of about $200,000,000.

Yours truly,

A. S. Cooper, City Engr.

West Superior, Wis., Jan. 22, 1893.

(We will not quarrel with our correspondent's estimate of probable traffic. If the canal were well built it might possibly be very large. But as he figures on a mean saving of $2.25 per ton from carrying freight 1,633 miles by the new canal, when, according to his own figures, the more valuable half of the same freight (wheat) is now carried by lake and canal for a mean rate of $2.29 between the same termini, and for only $3.36 by lake and rail, it is evident on the surface that the estimate of saving is greatly exaggerated. The mean all-rail rate is quite outside of the question, for the reason that it is chiefly a winter rate, when there is no water competition.

Moreover, does our correspondent seriously believe that the ships once in Lake Ontario would submit to be carted across country to New York, when a direct water-way of equal depth existed down the St. Lawrence, as it certainly would exist? Some might do so, but comparatively few. There should be deep-water navigation between the Atlantic and the Great Lakes, but the place of all others where it should be constructed is from Lake Huron to Montreal, via Lake Nipissing and the Ottawa River. This is not only the shortest route by 400 to 500 miles, but much the cheapest to build. Had such a route existed within the United States it would have been canalized long ago for 20 to 24 ft. navigation. That depth already exists over nine-tenths of the route, or more, and the rest could be added cheaply, the conditions being favorable for doing so.—Ed.)

THE DUNNING'S DAM.—PERSONAL.

Sir: I received yesterday from New York a pamphlet published by the American Cement Co., entitled, "History of the Portland Cement Industry in the United States." The pamphlet is profusely illustrated, and on pages 25 and 51 contains the two views which I herewith inclose, of the Dunning's Dam, near Scranton, Pa. These views are reduced reproductions of two large photographs, copies of which I presented sometime ago to the American Society of Civil Engineers.

I was much surprised to see that the views above mentioned bore the inscriptions, respectively: "R. S. Reeves and E. S. Gould, Engineers," and "E. S. Gould and R. S. Reeves, Engineers."

These inscriptions are just half true. In the summer of 1886 I was engaged by Mr. W. W. Scranton, President of the Scranton Gas and Water Co., as Consulting Engineer for the increased water supply contemplated by the said company. Among other work connected with this project, I designed and built the "Dunning's Dam," shown in the views referred to. This dam offers some bold and interesting features, and I was honored by a written request from the board of direction of the Am. Soc. C. E. to read a paper upon it, which flattering invitation engrossing occupations have so far prevented me from complying with.

As already stated, I designed and built this work myself, preparing the plans and specifications, and personally inspecting and directing the execution of the work, which was under my exclusive charge from first to last. I am alone responsible for its success or failure, and no man is entitled to have his name placed beside mine as engineer of the "Dunning's Dam"; nor can I permit, without protest, such association even in a trade publication like the one in question.

The insertion of this communication in your paper will be an act of justice to me, and I may add to Mr. Reeves, also, for I cannot believe that this false statement of his participation in my work was made with his sanction. His position in the gas and water company was one of the highest responsibility, but entirely distinct from the designing, specifying, engineering or building the dams. His reputation as an efficient and energetic officer in his own department is quite sufficient without enroaching upon that of others.

Very faithfully yours,

E. Sherman Gould, M. Am. Soc. C. E.

Consulting Engineer for Messrs. Runkle, Smith & Co., contractors for Havana new water-works.

Monte, No. 1, Havana, Cuba, Jan. 20, 1893.

STRENGTH OF GRANITE AND LIMESTONE.

Sir: Among the editorial notes in your issue of Jan. 12 we find reference to "the crushing strength of granite, the strongest of building stones, is commonly rated at from 12,000 lbs. to 15,000 lbs. per sq. in., when tested in 2-in. cubes, and only the hardest and toughest of the commonly used varieties reach a strength above 20,000 lbs." Reference is then made to a granite quarry recently opened on the Connecticut River, the product of which shows a crushing strength of from 30,000 to 36,000 lbs. (in round numbers) per sq. in. As you request any of your readers who may know of a record higher than this for a "building stone of any sort" to report it, we beg leave, taking into consideration the relative status of granite and limestone in the trade, to submit under this request the average crushing strength of our "Acme Avondale Stone," as reported to us by Sibley College, Cornell University; these tests were also made with 2-in. cubes:

Crushing Test.—Gray stone.....18,040 lbs. per. sq. in.
Light " .....12,112 lbs. per. sq. in.

Transverse test of lintels, tool dressed, 42 ins. between knife edge bearings, load with knife edge brought upon the middle between bearings:

Gray stone, section 6 ins. wide × 10 ins. high,
broke under a load of.....20,950 lbs.
modulus of rupture..... 2,200 "
coefficient of transverse strength 122 "

Light stone, section 8¼ ins. wide × 10 ins.
high, broke under a load of....14,720 "
modulus of rupture..... 1,170 "
coefficient of transverse strength 65 "

Absorption.—Gray stone..... .051 of 1%
Light stone..... .032 of 1%

Prof. Geo. A. Koeing, of the Michigan School of Mines, formerly of the University of Pennsylvania, pronounces this deposit a metamorphosed limestone, and in commenting on the durability of the stone says: ". . . . but durability depends, in northern climates, much more even upon impermeability to water; because when water changes to ice its volume increases, and the hardest rock, which is filled with minute cracks, soon becomes a mere crumbling aggregate of fragments when repeatedly exposed to hard and extended frosts, which penetrate to the very center of a wall. The degree of impermeability is measured by the weight of water which is absorbed by a weighed quantity of the rock, which has before been thoroughly dried out." He also says it is "very weighty if the absorption is 1% or less." We present the above because we believe our stone compares favorably in every particular with any granite, and that its qualities are worthy of record.

Very respectfully yours,

R. H. Hepburn.

Avondale, Chester Co., Pa., Jan. 25, 1892.

STANDARD GAGE OF WHEELS AND TRACK.

Sir: The paper on "Wheel Flanges," by Mr. Rhodes, in your issue of Feb. 2, is very timely, and I am greatly interested in the subject; but I do not understand your editorial comment where you say "a large part of the trouble will soon be removed by the elimination of the 4 ft. 9-in. gage on the Pennsylvania R. R. . . ." While they are changing the gage in many parts of the road, I don't see what it helps, because the rolling stock they have built since 1886, has, as I understand, had 4 ft. 5¼ ins. between the backs of wheels. I had a letter from Mr. T. N. Ely, in March, 1888, stating that 4 ft. 5¼ ins. was "standard distance inside of flanges." Have you any information of their building any rolling stock wider? I find so many chief engineers and others under the impression that the P. R. R. cars are wider than standard, that I think your comment was penned under the same. How is it?

Yours very truly,

Steelton, Pa., Feb. 4, 1893. Geo. W. Parsons.

(Our comment meant nothing more than that the example of the Pennsylvania will doubtless result in the early abandonment of the old gage of 4 ft. 9 ins., and with it will go the claim that a variation of ¾ in. in the distance between backs of car wheels is a necessity on account of the variation in gage of different roads. We were not aware that the Pennsylvania R. R. had adopted so narrow a gage as 4 ft. 5¼ ins. between backs of wheels, supposing that they used either the standard 4 ft. 5⅝ ins., or the outside limit of variation, 4 ft. 5½ ins. Still, so long as ½ in. difference of gage exists anywhere, more or less confusion of practice will result, which will be especially objectionable about frogs and switches.—Ed.)

RACE TRACKS.

Sir: Will you please print in the next copy of your paper in which it will be convenient for you to do so, the best plan for laying out a kite-shaped mile race track. Also, best plan for one-half mile circular track.

Yours truly,

Detroit, Mich., Jan. 30, 1893. M. H. D.

(Particulars of the laying out of race tracks have been given in our issues of July 5 and Oct. 11, 1890; Feb. 13, March 19, and June 23, 1892.—Ed.)

CORROSION OF IRON IN RAILWAY BRIDGES; CORRECTION.

Sir: In my letter in your issue of Feb. 2 the date in foot note in second column, page 111, also in the column at the asterisk, should be 1875, instead of 1885.

Yours truly,

New York, Feb. 2. Wm. Kent.

The total number of locomotives in Great Britain, according to a list compiled by Mr. Clement E. Stretton, an English engineer, is 16,800, of which 14,314 are in England and Wales, 1,841 in Scotland, and 705 in Ireland. The London & Northwesern Ry. has 2,648 locomotives; the Midland Ry., 2,020; the Great Western Ry., 1,660, and the Northeastern Ry., 1,560.

BROOKLYN BRIDGE TERMINAL STATION.

The latest development in the Brooklyn Bridge arrangements is the award of the contract for the new Brooklyn terminal station. This contract was awarded last week to the Phoenix Bridge Co., at $225,127. There were only two other bidders, Post & McCord, $229,312, and Milliken Bros., $244,955. These bids were exclusive of the elevators. The work will be commenced as soon as the contract is executed, and is to be completed within eight months after the final execution of the contract, which will be made at the next meeting of the bridge trustees.

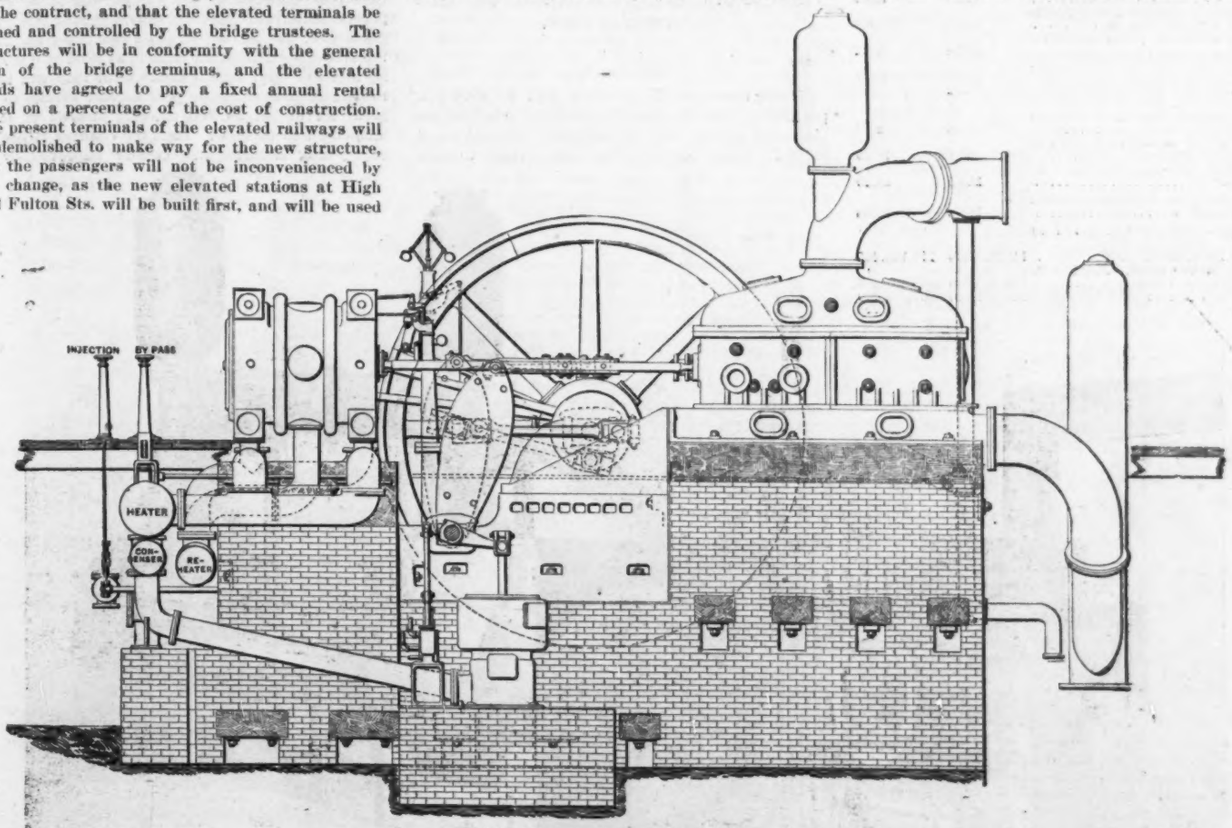
The contract includes the terminals of the Kings County Elevated Ry. and the Brooklyn Elevated Ry. The arrangements for these terminals were discussed by the terminal committee of the bridge trustees and by the representatives of the railway companies, and it was agreed that the plans prepared by Mr. C. C. Martin, Chief Engineer and Superintendent of the bridge, should be included in the contract, and that the elevated terminals be owned and controlled by the bridge trustees. The structures will be in conformity with the general plan of the bridge terminus, and the elevated roads have agreed to pay a fixed annual rental based on a percentage of the cost of construction. The present terminals of the elevated railways will be demolished to make way for the new structure, but the passengers will not be inconvenienced by the change, as the new elevated stations at High and Fulton Sts. will be built first, and will be used for traffic while the present stations are being removed.

According to the plans adopted, the new bridge station with the elevated terminals will constitute one structure, and will cover a space 358 ft. long and 90 ft. wide, extending over Sands St. and beyond High St. There will be two train platforms, each 250 ft. long and 20 ft. wide, and each platform will have a track on both sides, by which arrangement, it is claimed, trains can be run at a headway of 45 seconds. While one train is discharging passengers at one platform another will be at the outgoing platform on the opposite side.

The main entrance from the street to a waiting room, which will be on a floor below the platforms, will be from Washington and Sands Sts., and from the new plaza, where passengers from the street cars will be discharged. This waiting room will be 100×63 ft., and will be well lighted and warmed and handsomely finished. At its exit to the bridge platform will be two large ticket booths with windows in each for three ticket sellers and a separate passage for passengers who are supplied with tickets. At the south end of the waiting room there will be two retiring rooms, 30×40 ft. each, and the stairway that leads from it to the center of the railway platform will be wide enough to avoid serious crowding, even in the rush hours.

The terminals to be built for the Brooklyn Elevated Ry. will be located at High and Sands Sts., the latter being a part of the regular bridge terminus. A loop on Fulton St., over the tracks of the Kings County Elevated Ry. will connect the two stations and make a continuous road. The trains which stop at the High St. station will not stop at the Sands St. station, and the trains that stop at Sands St. will begin the uptown trip from that point, without making a stop at High St., after going round the loop. Both stations will be connected with the bridge platforms by separate stairways, and each of the stations will have three platforms.

The Fulton St. station of the Kings County Elevated Ry. will be located between Sands and High Sts., and a covered passageway over the plaza will give access to what will, at that point be a third story of the bridge station proper. From here the passengers will descend to the bridge railway platform by stairs, and incoming passengers will have similar stairs to reach the elevated road.



SIDE ELEVATION OF BLAKE HIGH-DUTY PUMPING ENGINE.

TESTS OF THE BLAKE HIGH-DUTY PUMPING ENGINE.

The accompanying illustrations show the high-duty pumping engine which was installed about a year ago at Newton, Mass., by the Geo. F. Blake Mfg. Co., and of which two duty tests have now been made. The Blake company has earned an enviable reputation by its work in the manufacture of the ordinary duplex and direct acting pumps, having, according to the statistics in the "Manual of American Water-Works" for 1888, pumping machinery in service on public water supply systems with an aggregate capacity of over 200,000,000 gallons daily. Now that the company has entered the lists with an engine for which the highest duties are claimed, the result of its work in this direction will be watched with much interest. Four other high-duty engines of similar design to that at Newton have now been turned out by the Blake company. One of these is at work at the Toronto water-works, and the other three are in use pumping water for irrigating purposes in the Sandwich Islands.

As seen by the illustrations, the Blake engine consists of high and low pressure steam cylinders, with Corliss valve gear, each driving a double-acting pump, the plunger of which is mounted on the same rod as the steam piston. The steam cylinders are far enough apart to permit the placing of the fly-wheel between them. The fly-wheel is driven by a connecting rod which is attached to a rocking beam, and the beam worked from the low-pressure cylinder drives the air and feed pumps. With this arrangement the force on the steam pistons is transmitted to the pump plungers in the most direct manner, and with the minimum loss by friction. The office of the fly-wheel is to act as a reservoir of power, absorbing the excess of energy from the steam piston on the first part of the stroke, and giving it out on the last part. It also equalizes the power between the two sides of the engine, for the cranks being set at 90°, when one steam piston is working with about its maximum effect the steam behind the other has expanded to a point where its total pressure is below the resistance of the pump plunger.

Steam is taken from the boiler at about 125 lbs. pressure, and goes through a reheater in its passage from the high-pressure to the low-pressure cylinder. A jet condenser is used, and the exhaust steam is passed through a feed-water heater on its way to the condenser. The boiler feed-pumps take their supply from the hot well and force the feed-water through the heater and thence to the boilers. A centrifugal governor regulates the speed of the engine by controlling the point of cut-off in each cylinder.

The principal dimensions of the engine at Newton are as follows:

Cylinder diameters, h. p... 21 ins.; l. p.....	42 ins.
Plunger, diameter.....	13½ ins.
Piston rod, diameter.....	4 "
Stroke.....	48 "
Air pump, cylinder diameter (one single acting)	26 "
Air pump stroke.....	12 "
Feed pump cylinder, diameter.....	4½ "
Feed pump stroke.....	6 "
Grate surface of boiler.....	41.1 sq. ft.

The contract for the sale of this engine specified that it should have a capacity of 5,000,000 gallons per 24 hours, against a static head of 235.25 ft.,

and that it should be capable of performing a duty of 115,000,000 ft.-lbs., with a quantity of dry steam equivalent in its total heat to that required for the evaporation of 1,100 lbs. of water from and at 212° Fahr., or 1,062,600 B. T. U. This, it will be seen, is somewhat in excess of the Am. Soc. M. E. standard, which bases the duty on the foot-pounds of work done per 1,000,000 heat units.

Two tests have been made on this engine. The first was made by Prof. C. H. Peabody, of the Massachusetts Institute of Technology, on April 30, and the second was made by Mr. F. W. Dean, M. Am. Soc. M. E., Consulting Engineer for the city of Newton, on Sept. 30 and Oct. 1, 1892. The following table gives the principal results obtained in both tests:

	Peabody's test.	Dean's test.
Duration of test, hours	10	24
Ave. speed, revs. per min.	37.7	39.1
Ave. speed, ft. per min.	251.4	260.7
Ave. steam pressure boiler, lbs.	122.6	125.6
Ave. steam pressure at throttle, lbs.	119.9	122.3
Resistance against pump plungers, lbs. per sq. in.	116.5	105,986
Work done by pump plungers, HP.	242.8	229.2
Steam consumption per I. HP. per hour, lbs.	15.08	13.97
B. T. U. per I. HP. per minute.	272	253
Exaporation; lbs. of water:		
Per lb. of coal from feed to boiler pressure	9.83	9.91
Per lb. of combustible, feed to boiler pressure	10.42	10.69
Per lb. of coal from and at 212° F	11.25	11.20
Per lb. of combustible from and at 212° F	11.93	12.08
Duties based on water fed to boiler; ft.-lbs.:		
Per 1,000,000 B. T. U.	116,170,000	118,128,445
Per 1,100 × 965.8, B. T. U. (Newton basis)	123,420,000	125,497,823
Per 100 lbs. of coal burned	125,400,000	127,779,469
Duties based on heat received and rejected by engine; ft.-lbs.:		
Per 1,000,000 B. T. U.	117,850,000	119,406,777
Per 1,100 × 965.8, B. T. U., Newton basis	125,200,000	125,855,372
Per 100 lbs. of coal burned	127,200,000	129,162,443

It will be seen from the above that the economy of the engine attained in the tests made by the city's expert was superior to that obtained in the tests made on the contractor's behalf. It will be noticed that in Mr. Dean's test the engine was run at a higher speed and with a higher boiler pressure, and that the engine had been six months longer in service, all of which would contribute toward the increased efficiency shown. There may have been other differences in the method of making the test which contributed to the result. For example, in Prof. Peabody's tests, the condensation from the high-pressure cylinder jacket was trapped off and thrown away, and no allowance was made for the heat thus lost.

In Prof. Peabody's tests the coal burned per hour per square feet of grate surface was 9.4 lbs. The steam was remarkably dry, containing only 0.7% of moisture. The division of work between the cylinders was excellent, the high-pressure cylinders indicating 117.75 HP., and the low-pressure cylinder 135.73. The latter drives the air and feed pumps, and has a greater friction than the high-pressure cylinder, which probably make its effort deliverable to the pump plunger just about equal to that of its mate. The total loss by friction, as determined by the difference between the indicated horse power and the work done on the pump plungers, was 4.2%. During the test the high-pressure cylinder was cut off at one-fifth stroke, and the low-pressure at one-fourth stroke. The duty of the engine in coal per I. HP. per hour was 1.51 lbs. The accompanying indicator diagrams are reduced from those taken in Prof. Peabody's tests.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XLI.

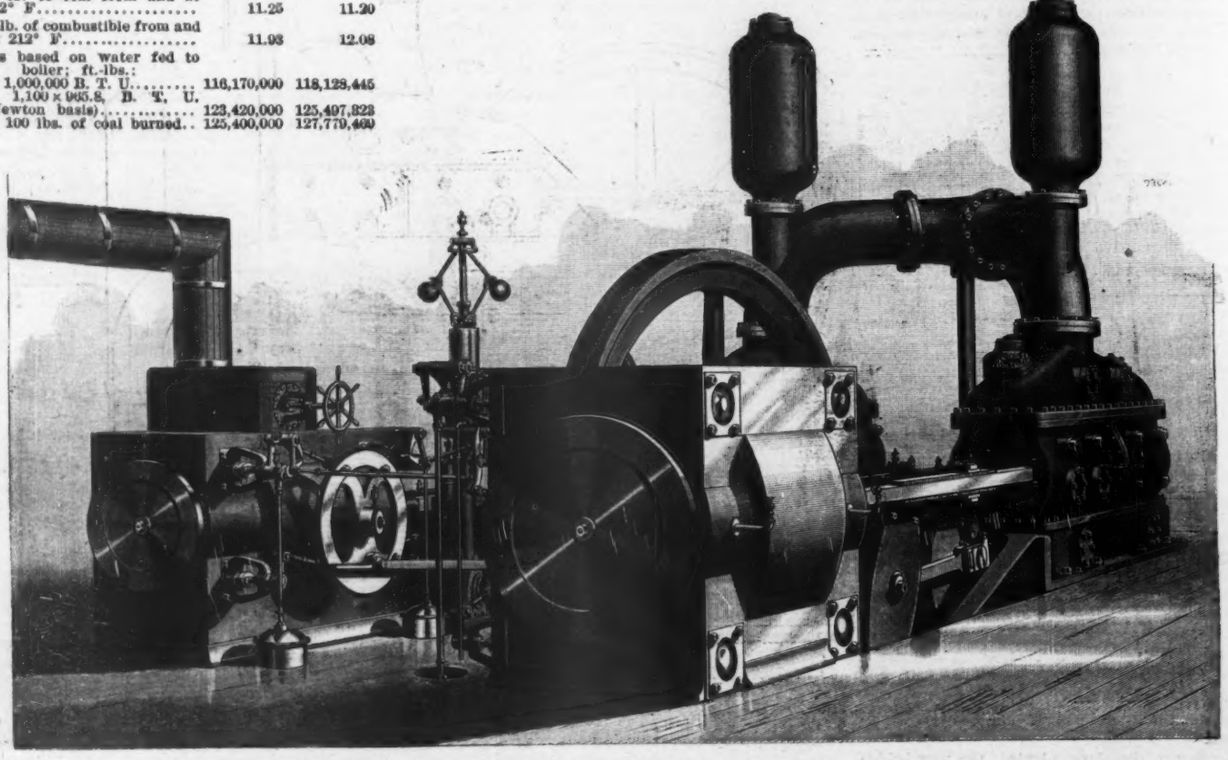
Conclusion.

Having now labored for more than 40 weeks in presenting what information we could about our engineering schools, we feel ourselves entitled to at least 12 weeks' vacation; and we propose to take it, giving in this issue only a brief summary of the results of the inquiry.

Whatever the imperfections of these articles, and from their very nature they must be imperfect, they have given the first approximately accurate information about our engineering schools as a whole which has ever been collected. We were unable to find in the reports of the Bureau of Education or elsewhere even a list of our engineering schools, but were compelled to compile it by means of miscellaneous inquiries as best we could. We think we at last made the list tolerably complete for 1890-91, but every year new schools are organized, and older schools of the debatable kind advance to the standing of true engineering schools. On the other hand, we have learned in our inquiries of but two engineering schools once established which have been abandoned, viz., the engineering school of Syracuse University and the Polytechnic College of Pennsylvania. Both were early established; the first was never a very successful one, but the last occupied for many years a very prominent place, has a large number of living graduates, and was apparently firmly established when it was suspended for reasons which we have never fully understood; probably lack of means.

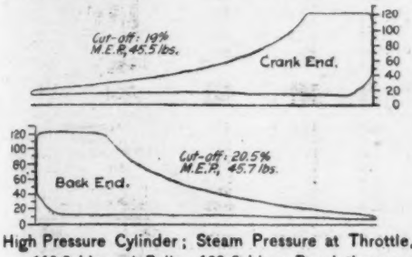
Definite figures of the growth of engineering education, as shown by the yearly increase in number of graduates, have never been collected before, and must, we are sure, have been a great surprise to our readers as they were to us. In beginning this investigation we had no idea that we were about to describe so great and so rapidly growing an interest. Moreover, the evidence, if given in geometric ratio, which we have given, affords all but convincing evidence that engineering education—using the term in its broadest sense—is even yet in its infancy, will continue to gain rapidly on the older types of classical education, and is destined in the future to equal, if not overshadow it in number of graduates. If this meant that the education of the future was to be of a purely utilitarian type, we should regard this as a great evil; but all the signs of the times are that the stronger engineering schools at least will steadily increase their requirements until they will tend to become post-collegiate professional schools to as great an extent as the existing schools of law, medicine and divinity. That the chances in life of any young engineer are greatly improved by a broader general training than the engineering schools proper can be expected to furnish, or than their requirements for admission now demand, we fully believe.

The facts heretofore presented seem to us conclusive evidence that in both quantity and quality of engineering education we are even now, and soon shall be still more, far ahead of any other country in the world. It is probable that some of the German and French schools are ahead of our own in the thoroughness of their training in some special lines, as in mathematical and drafting work, as is but natural from the fact that their requirements for admission are more stringent, but that the training even of these few schools is better fitted to turn out men likely to become successful engineers, we do not believe. We cannot pretend to speak of these foreign schools from as intimate knowledge as of the American schools; but investigation has satisfied us that a dozen or twenty of our

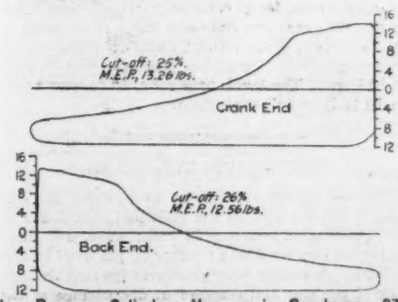


BLAKE HIGH-DUTY CROSS-COMPOUND PUMPING ENGINE AT NEWTON, MASS.

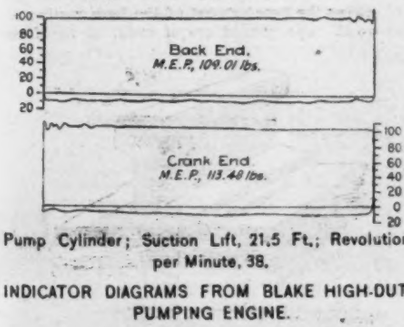
leading schools at least may fairly challenge comparison with any in the world. For training men to succeed now and here in America, at any rate, the best of our schools are far ahead of any foreign schools, both in their methods and their results. Considering how new a thing engineering education is, and how different from and how much more costly it is than the mere book learning of the older colleges, marvellous progress has been made in perfecting it in the few years since it began on this continent. If we have not seemed to recognize this, but to be more inclined to dwell upon what seemed to us defects, it has been only because it seemed the more profitable, if not the pleasantest course. "Faithful are the wounds of a friend." Mere applause and patting on the back may be the pleasantest course for all concerned, but it is not particularly useful; while honest criticism is sure to do good, if it does anything. If not well founded it falls to the ground and has no effect; if it is well founded, it must have its effect. Evidence in plenty has come to us that these arti-



High Pressure Cylinder; Steam Pressure at Throttle, 119.9 Lbs.; at Boiler, 122.6 Lbs.; Revolutions per Minute, 37.7.



Low-Pressure Cylinder; Vacuum in Condenser, 27.1 Ins.; Revolutions per Minute, 37.7.



Pump Cylinder; Suction Lift, 21.5 Ft.; Revolutions per Minute, 38.

INDICATOR DIAGRAMS FROM BLAKE HIGH-DUTY PUMPING ENGINE.

cles have had such good effect in many individual instances at least, by bringing to the attention of colleges how their practice differed from others, or was in itself defective.

These articles will not be republished in book form, as has been promised. We have reached this conclusion only within the last week, and only because evidence has come to us in the eleventh hour that a great many minor errors were contained in the original returns sent to us from the several colleges, so that even the statements on such a simple fact as the length of the college year cannot be fully relied on. We have no evidence, and we do not believe, that these errors, even if all corrected, would materially modify any of the totals or averages, or modify at all any of the opinions or general conclusions we have expressed, but they might in cases misrepresent individual colleges, and although such colleges would have only themselves to blame therefor, in most cases, we feel unwilling to incur the risk of doing so.

As an illustration of the difficulties which have beset us in obtaining accurate information, and as the actual deciding cause which has decided us to melt up the plates already made and abandon our intent to republish these articles in book form, we may cite the results of inquiry started by the following letter. The letter was marked "Not for publication," but we venture to give it, suppressing the name of its author, as it relates directly to a subject we have lately discussed, the length of college years and vacations; and is the strongest impeachment we have yet received of the correctness of our conclusions, because it impeaches the facts on which we based them. The letter is dated Jan. 20, 1893, and comes from a Western college.

Dear Sir: Other matters have made it impossible to call your attention to certain points doubtless overlooked by you when writing your editorial of Jan. 12, upon the length of college vacations. An examination of the catalogues of the "40-week" colleges, represented in your diagram, shows that the total time, from the beginning of examinations for new students to the end of commencement festivities, in each case does not exceed 40 weeks. From the 40 weeks must therefore be deducted the time spent in examinations for new students, commencement festivities, and the Christmas and Easter holidays. The result is that the actual time spent in college instruction for these colleges does not average more than 36 weeks per year. A number of the colleges included in your diagram have evidently reported the number of weeks actually spent in college instruction, if the calendars presented in their catalogues are to be trusted; and it is for this reason, in most part, that the considerable difference shown in the diagrams exists, if we include in the comparison only four-year courses. This makes the average time spent per year in actual instruction at the best engineering colleges about 36 weeks, and the maximum time probably not exceeding 38 weeks. Such uniformity evidently betokens some good cause. The laziness of the professors evidently cannot be sufficient reason, for the competition between colleges is sharp, requiring each to present the best possible advantages in order that it may hold its students. Moreover, the average professor of engineering is as ambitious to do the best work, and the most of it, as is his brother in practice. He depends upon the results of his work as a teacher for position and advancement just as much as does the man in professional practice. The teacher does not fix the length of the college year, but it is fixed by the educational conditions. Whether it would be advantageous to lengthen the college year, as it is now constituted, I will leave for more experienced educators to discuss. That many of the most successful men, both in and out of the colleges, think the present year is long enough is shown by the uniformity in the length of term, as already pointed out. You will find this matter treated from the point of view of the general educator in various issues of the New York "Nation" during the past few months. No suggestion looking toward increasing the amount of work done each year by the individual student is made by that paper, and we may rely upon its view as unprejudiced. Finally, let me suggest to you that many of the men now holding the positions of professors of engineering have previously been in successful practice, and that these men, as far as I can discover, usually work fully as many hours in their present positions as they would do if in practice. The professor's "vacation" is often the time in which he carries on the most confining work of the year.

I trust before committing yourself to the pages of the proposed book you will again examine the question, as I am certain you will find the case against the "professor" is not so black as your present views would seem to warrant. The reputation for fairness that always accompanies an enviable engineering reputation will doubtless lead you to review the question.

Our correspondent will doubtless admit that there is a flaw in his logic, even if his premises be admitted. The latter do not of themselves even tend to prove that there is "some good cause" for long vacations. They only tend to prove that there is a cause which may be either good, bad, or indifferent, known or unknown. As we propose to again review the whole question on its merits at a later day, we will not now discuss it again further than to say that we as yet see no reason to modify the substance of any opinions we have expressed on this head.

Moreover, we find that our correspondent is not quite correct in his statements of fact, though in substance he is correct. To test his statements we have selected a list of 22 leading engineering schools from which we received full and direct returns, and among them answers to these two questions:

"Length of course? —— years of —— weeks each."

"Total amount of vacation work required, weeks; Dept. C. E. ——; Dept. Mech. E. ——; Dept. Min. E. ——."

The answers to these questions, in comparison with what an examination of the college calendar indicates, is shown in full in the following comparative table, from which it will be seen that there are, in almost every instance, considerable discrepancies, some exaggerating the calendar length of college year, and some the contrary, but, as a rule, considerably exaggerating the length of college year, when interpreted from the catalogue by the rule which we have followed—and which seems to us the natural and obvious rule—as follows:

The time from the day when instruction begins to the close of the annual commencement exercises, by whatever name called, has been considered the college year, less any intermediate recesses of one week or more. No attention has been paid to recesses of one to four days, but when the recess was more than five days long the actual length of the recess in weeks and tenths, at the rate of 0.2 week per school day, has been deducted. We confess that it never occurred to us that any other rule than this could be followed, in answer to so simple and definite a question as the first above quoted, yet it seems that the almost invariable rule was so to interpret the question as to warrant reporting several weeks more than the application of this rule warranted. Under our correspondent's logic above, we suppose that we ought to conclude that there was "some good cause" for such a discrepancy. To ascertain if there was or not we have made an inquiry of the first college only on the tabulated list, which had originally reported "4 years of 40 weeks." We learned in response that the 40 weeks was reported because "our year is divided into two terms called 20 weeks each"; but that a separate return of distribution of time to the various studies, which had been sent in later, showed that, deducting all recesses even of a single day and all days of general college exercises, there remained 35 weeks of actual recitations and class exercises; while our rule, as above stated, places the actual college year at 37.6 weeks, which has recently been still further increased, as heretofore noted.

We have no doubt that the substance of the same explanation applies to all the other colleges in the list where there is an excess discrepancy. We find, however, that there is at least one college in the list, the Stevens Institute of Technology, of Hoboken, N. J., which actually has the 40-week year reported, except in the freshman year. This total is attained because it has, in addition to its three regular terms, a "supplementary term" of nearly four weeks (Tuesday, June 24, to Saturday, July 19, in 1890), during which the sophomore, junior and senior classes "devote eight hours per day to the department of experimental mechanics and shop work." The Rensselaer Polytechnic Institute has just adopted a similar supplementary term (though not so termed) for continuous field practice. Granting it to be true that the average brain of average students cannot stand more than 34 weeks of study, why should not, and why do not, all engineering schools fill up their course to at least 40 weeks of instruction by supplementary courses of instruction like this? Such instruction would rest the overtaxed brains of the students as much as complete idleness, while it would also give them another kind of instruction of the very highest importance to their future success, especially in their first years after graduation, and of which they can hardly have too much. What "good cause" prevents?

According to the above definition of what is and is not "vacation," the college years of 21 colleges appear from the table below to be 31.0 weeks in all shorter than the several years reported to us, an average apparent discrepancy of 1.47 weeks in excess. Deducting the four colleges whose returns to us agree with the showing of their calendars, and deducting also the three colleges which reported to us a shorter college year than their cal-

endar appears to show, the mean apparent excess of the remaining 14 colleges is 2.51 weeks; the apparent discrepancy varying all the way from 0.4 to 7.4 weeks, so as to forbid the suggestion which naturally arises, that these errors are all due to some common cause. It is possible that the table may contain some small errors of our own, as it is more confusing than one would think to check off so many different calendars, each having its own peculiarities of form; but we hope not.

Statement of the Length of College Years and Vacations as Reported to Us and as Indicated by the College Calendars.
(No recesses of less than one week considered. The return from Yale was unofficial and the college authorities were not responsible for it.)

		Length of Course as Reported to us in special returns.		Apparent College Year by Calendar						
No.	College.	Length course.	Req'd. vacation work.	Calendar year.	Summer Vacation, Dates.	weeks.	Calendar recesses	Total wks. vacation.	College year, wks.	Apparent Over-statement.	Discrepancy, Under-statement.
1	Rens. P. I.	"4 yrs. of 40 wks."	Thesis	'91-2	6-17 to 9-12	13.	1.4	14.4	37.6	2.4	....
2	Harv	"4 yrs. of 38 wks."	None.	'91-2	6-27 to 10-1	13.	1.6; 1.	15.6	36.4	1.6	....
3	Yale	3 yrs. of 38 wks.	.....	'90-91	6 24 to 9-25	13.	2.6; 1.	16.6	35.4	2.6	....
6	U. Mich	"4 yrs. of 36 wks. exclusive of recesses."	None	'91-2	6-30 to 10-1	13.6	2.2; 1.4	17.2	34.8	1.2	....
9	Columbia	"4 yrs. of 32 wks."	20 wks. C. E and M. E.	'90-91	6-10 to 10-6	16.4	1.6	18.0	34.0	....	2.0
10	Wash. & L.	"4 yrs. of 39 wks."	None	'90-91	6-17 to 9-10	12.	1.	13.	39 9	correct.	
11	Mass. I. T.	"four years of thirty-three weeks each, including examinations"	In C. E. 4 wks. at end 3d year	'91-2	6-2 to 9-28	17.	1.	18.	34.	....	1.0
12	Lehigh	(Not stated)		'90-91	6-17 to 9 9	12.	3.	15.	37.	....	....
13	U. Va	"3 yrs. of 39 wks. of 6 days each"		'91-2	7-1 to 10-1	13.	.....	13.	39.	correct.	
14	Cornell, C. E.	"4 yrs. of 36 wks."	None.	'90-91	6-18 to 10-1	15.	1.6; 1.4	18.	34.	2.0	....
18	Wash. U.	"5 yrs. of 40 wks."	None	'90-91	6-11 to 9-17	14.	1 4	15.4	36.6	3.6	....
19	U. Vt.	"4 yrs. of 38 wks."		'89-90	6-25 to 9-12	11.	2.0; 2.0	15.	37.	1.0	...
20	Kan. A. C.	"4 yrs. of 40 wks."		'90 91	6-10 to 9-11	13.	2 2	15.2	36.8	3.2	....
21	Worc. P. I.	"3½ yrs. of 38 wks. each" (so also in catalogue)		'91-2	7-3 to 9-8	9.4	2.0; 1.4	12.8	39.2	....	1.2
25	U. Pa.	"4 yrs. of 40 wks"	"4 wks. sats."	'91-2	6-11 to 10-1	17.	1.0; 1.4	19.4	32.6	7.4	....
26	Stevens	"4 yrs. of 40 wks."	None	'90-91	6-18 to 6-24 and 7-19 to 9-24	10.	2.0	12.0	40.0	correct.	
27	U. Wis.	"4 yrs of 37 wks."		'90-91	6 17 to 9-10	12.	2.0; 1.0	15.	37.0	correct.	
30	Cornell, M. E.	"4 yrs. of 40 wks."	None	'90-91	6-18 to 10-1	15.	1 6; 1.4	18.	34.	6.0	....
34	U. Minn.	"4 yrs. of 37 wks."	None	'89-90	6-6 to 9-10	13.2	2.2	15.4	36.6	0.4	....
38	U. Ill	"4 yrs. of 38 wks."	None	'90-91	6-9 to 9-15	14.	2.0	16.	34.	2.0	....
46	Purdue	"4 yrs. of 38 wks." (so also in catalogue)	None	'90-91	6 8 to 9-9	13.	2.0	15.	37.0	1.0	....
47	Rose P. I.	"4 yrs. of 37 wks."	None	'90-91	6-19 to 9-17	12.6	1.2; 2.0	15.8	36.2	0.8	....
										35.2	4.2
		Summary for 21 colleges (31.0 weeks net excess)								1.47	....
		Mean apparent difference between the actual year and the reported year								1.82	....
		Deducting the four colleges correct, mean apparent error in excess of remaining 17								2.51	....
		Deducting also the three colleges in deficit, mean apparent excess of the 14 in excess									

If, instead of computing the year as above, we had deducted all recesses of a day or more, and all days on which work of instruction of some kind was not going on, the apparent college year would have been some two weeks or so shorter yet, as nearly as we can judge.

In lieu of printing these articles we propose hereafter to establish in this journal a department of "Notes from the Engineering Schools," in which the advances, improvements and changes of practice in the several engineering schools will be promptly chronicled (if we are informed of them) for the common good of all. In the lack of any other "information exchange" between the several engineering schools we trust that this department will be valuable and helpful, and we beg the professors and officials of the several schools to aid in making it so by sending us prompt information of facts suitable to appear in it. It will not necessarily appear in every issue, and it will be quite impossible for us to seek to make it an absolutely complete record of any department of college work, but, on the other hand, we shall expect, from time to time, to ascertain by circular certain specific facts which can be furnished to us without much labor; and thus give a nearly complete comparative exhibit of those specific facts for all our colleges. One of the earlier exhibits of this kind which we shall endeavor to give will be a diagram showing for each day in the year just what engineering schools are then in session, and which are not.

In this column of "Notes" will also appear shortly a number of corrections and miscellaneous statements which we have received from the various colleges in relation to the prior contents of these articles. What further we may have to say in relation to college questions will appear either in this column of notes or on our editorial page. Among other things, it is impossible for one to spend a good part of a year in the study of the facts for these articles without forming some impressions as to "The Ideal Engineering School" which he will be apt to think have some value. That subject we shall discuss shortly.

We are rejoiced to learn that the resignation of Prof. Wm. H. Burr, from the Laurence Scientific School, to accept an appointment at Columbia College, was influenced chiefly by the fact that for personal reasons he preferred New York as a place of residence, and that it was in no way influenced by any disappointment in his work at the first named school, which is persistently pursuing a progressive policy.

THE RELATIVE ELEVATIONS OF EUROPEAN SEAS.

The International Geodetic Survey of Europe has been investigating for some time the relative elevations of the different neighboring seas. A difference in level is found to exist, but it is not as large as was generally supposed. The results here given have taken into consideration the various natural causes affecting the "sea-level"; such as varying atmospheric pressures; oscillations caused by the effect of the sun and moon; sea currents, mean temperatures, etc. The expression "difference of level" is preferred to that of "sea-level"; as the latter form arbitrarily assumes the surface of the sea to be a horizontal plane; whereas it is not a plane, and differs at different points in its relation to the earth's center. The first form given deals with results directly obtained by instrumental work, and does not take into consideration the form of the surface.

The different seas of Europe have now been connected by careful surveys and reductions made dealing with the above sources of error, after a manner which need not be detailed here. For the north of Europe, the Prussian Geodetic Institute referred all levels to Swinemuender, on the Baltic Sea. The mean water level was obtained for the chief parts of the Baltic and North Sea, and the relative mean water levels of these and the other European seas was reduced to the mean water found for Swinemuender. The general results may be given as follows for some of the chief points:

	Metres.
Amsterdam referred to M. W. at Swinemuenden.	+ 0.093
Ostend " " "	+ 0.072
Boulogne " " "	+ 0.179
Havre " " "	+ 0.299
Brest " " "	+ 0.429
Marseilles " " "	— 0.668
Cette " " "	— 0.431
Triest " " "	— 0.499
Nizza " " "	— 0.811
The Helder " " "	— 0.038

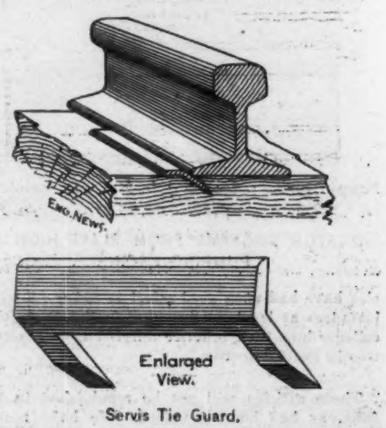
The general result shows that the level of the North Atlantic Ocean, along the coast of Bretagne, is the highest, and the Mediterranean Sea the lowest. Also that the North Sea is higher than the Baltic, and this latter sea is highest toward the east. The probable cause of the inland seas, the Baltic and the Mediterranean, being lower than the open ocean is their higher percentage of salt caused by greater evaporation and consequent greater density. According to hydrostatic laws, a fluid of greater density must be at a lower level. A surface current will occur between connected seas, which current remains constant as long as the percentage of salt remains the same. This interchange is very plain in the Mediterranean Sea, in which the percentage of salt increases from the mouth of the Rhone toward the east; while the surveys show a gradually lower sea surface from Cette to Nizza.

The high level of the mean-water gage along the northwest coast of France is caused by the fact that the tides in the North Atlantic Ocean are generally higher than in the other seas. The flood-tide increases in height if the current meets a coast directly opposite, as is the case south of Bretagne and west of the peninsula of Contation. The relatively high level in the Channel is caused by its funnel-like shape, backing up the entering flood tide. The rise of the Baltic toward Memel is explained by the prevailing west winds, which force the water east.

The question has been frequently asked, How accurately can the level of mean tide be ascertained? The investigations made by Mr. Seibet, at Swinemuenden, show that 1,994 years of observations would be required to obtain the height of mean-water level correctly within one millimetre; 80 years are sufficient for a mean error of plus or minus 5 mm., and 20 and 10 years for observations correct to within plus or minus 10 mm. and 14 mm. The levels here referred to were based on 10 to 12 years' observations.

THE SERVIS TIE-GUARD.

The use of steel tie-plates to prevent the cutting of wooden ties by the rails has been found to effect a decided economy in track work, and these plates are now used on a number of railways in this country. A rather novel device to prevent the cutting of the ties and consequent disturbance of the rails is the Servis steel tie-guard, which gives a metal bearing to the edges of the base of the rail and leaves the greater part of the base resting on the wood. The guards are of steel, of the form shown in the accompanying cut. They are 4 ins. long, and are intended to be used on both sides of the rail, or four to each tie. They are strong enough to stand driving into an oak tie, and are driven after the rails have been spiked down in the usual way. The device seems to be open to the objection of forming a lodging place for the water at the edge of the rail, which, with the cuts made by the prongs of the guard, might cause rapid rotting of the wood. The tie-guard is sold by the American Railway Equipment Co., 15 Cortlandt St., New York.



Servis Tie Guard.

CONDENSED WATER-WORKS STATISTICS OF BATTLE CREEK, MICH.

The amount of valuable information regarding a water-works system which can be compressed into a small space and presented both to the local and general public at small expense is well illustrated by the condensed statement regarding the water-works at Battle Creek, Mich., for the four years 1889 to 1892, given herewith. Many water-works publish no annual reports, as we believe was formerly the case at Battle Creek, to the loss of their officials and city and to others interested in such matters. Other works publish a report made up almost wholly of an inventory of property, or other information, which often needs only to be filed for public inspection. A relatively small number of reports give figures showing the growth of the works, or, indeed, any figures of general value beyond a few covering the current year.

The Battle Creek figures are self-explanatory, and need no further comment. Mr. S. O. Bush is president of the Board of Public Works of Battle Creek, and Mr. W. W. Brigden is superintendent of the water-works and chief engineer.

Statistics of the Water-Works of Battle Creek, Mich.

Condensed statement for years 1889, 1890, 1891 and 1892:

	1889.	1890.	1801.	1892.
Total cost for construction to Dec. 31	$151,116	$163,906	$178,901	$194,701
Expended for mains	8,953	9,563	5,500	.....
Expended for service pipe	2,426	1,505	1,900	531
Average cost of taps	10	10.50	9.50	6.50
Length of mains, miles	17	19½	20.7	21.7
Street valves	118	146	157	161
Public hydrants	150	179	198	205
Number of meters and 1 register	28	57	169	512
Per cent. of taps metered	3.5	6	15	42
Per cent. of water metered	.....	.....	23	35
Number of taps	779	921	1,133	1,217
Number of fountains, public	1	1	1	1
Public water troughs	2	2	2	2
Operating expenses	$5,047	$5,730	$6,248	$5,966
Expenses charged pumping account	2,844	3,285	3,381	3,341
Cost of coal purchased	1,041	1,440	1,173	858
Water pumped, millions of gallons	118	159.5	179	161
Average water pumped per day, gallons	324,000	410,000	490,000	442,000
Average cost per 1,000 galls., pumping expenses, cts.	2.4	2.2	1.9	2
Average cost per 1,000 galls., total operating exp., cts.	4¼	3.7	3.5	3.7
Average cost per 1,000 galls., operating expenses and interest, at 4½% on total cost, cts.	10	9	8	9.1
Estimated population of city	12,800	13,400	14,000	14,400
Water used per day, per capita, gallons	25	31	35	31
Water used per day, per tap, gallons	400	500	480	360
Level of water in lake below gage, Dec. 31	13.5	13.4	13.9	10.5
Rainfall, inches	25	34.91	26.73	3.193
Average rainfall in this locality, inches	.....	.....	.....	35
Receipts for water, including advance on applications	$8,423	$11,191	$10,759	$10,246
Receipts per tap	11	12	9.50	8.42
Average receipts per 1,000 galls. for metered water, cts.	.....	.....	9.5	9.5
Average receipts per 1,000 galls. for unmetered water, cts.	.....	.....	5½	5.5
Receipts for licenses	$15	$10	$10	$15
Duty of coal used while running, ft.-lbs.	30,000,000	31,000,000	31,000,000	31,000,000
Duty of total coal used, ft.-lbs.	19,000,000	21,000,000	22,000,000	24,000,000

Size and length of water mains, Dec. 31, 1892:

Size, ins.	Length, ft.	P. c. of total.
4	14,701	13
6	49,476	44
8	32,133	29
12	3,631	3
16	11,757	11
Total	111,698 ft., or 21.7 miles.	

Number, Kind, Size and Ownership of Meters, Dec. 31, 1892:

Kind of meters.	Sizes, ins. ½	⅝	¾	1	1½	2	3	Sold.	Rent.	Total.
Crown	339	.	60	14	2	5	2	101	321	422
Gem	...	.	...	..	..	.	1	...	1	1
Worthington	...	.	...	..	..	1	1	2	...	2
Union rotary	...	2	...	..	..	.	.	1	1	2
Elevator register	...	.	...	..	..	.	.	1	...	1
Hersey	...	.	35	..	..	1	.	11	25	36
Empire	9	.	1	..	..	.	.	1	9	10
Nash	18	.	18	..	..	.	.	33	3	36
Thomson	...	2	...	..	..	.	.	...	2	2
Total	336	4	114	14	2	7	4	150	362	512

A FLOATING SWING BRIDGE.

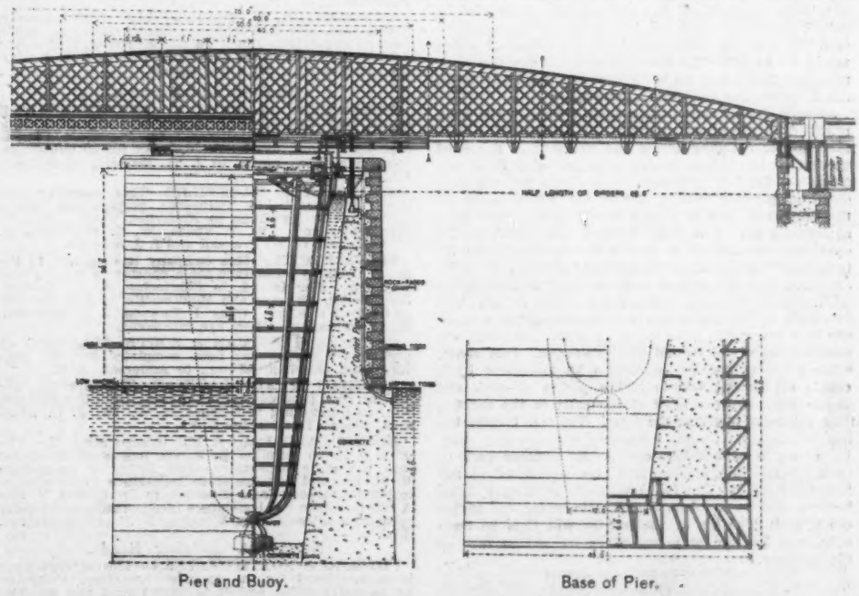
The novel arrangement of swing bridge illustrated herewith is the prize design for a highway bridge across Darling Harbor, at Sydney, New South Wales. As noted in our issue of Aug. 18, 1892, the prize was awarded to the design submitted by A. C. Pain and R. Lilljeqvist, and further particulars of the location, and the conditions of the competition, were given in our issue of Sept. 29. The proposed bridge is to be about 1,100 ft. long, with a drawspan having a clear opening of 60 ft. on each side of the pivot pier. The headway is to be 24 to 26 ft. The bridge will have a 42-ft. roadway and two 12-ft. sidewalks, but the drawspan may be 38 ft. wide, including sidewalks. The conditions required the bridge to be designed for a live load of 130 lbs. per square foot of roadway and sidewalk, and the roadway is to be capable of carrying a rolling load of 30 tons on two pair of wheels. The principal feature of interest in this design is the arrangement for carrying and revolving the swing span, and from an article in "Industries," of London, we take accompanying description and illustrations.

The swing-pier, with a diameter of 40 ft. at the top, is hollow and partially filled with water, so as to allow an inverted hollow cone of steel to float freely inside it. This cone has a buoyancy somewhat in excess of its own weight added to that of the superstructure. Previous to opening the bridge, the superstructure of the swing span is made to float, the only resistance to turning being the skin friction of the buoy assuming the wind pressure to be negligible. The time required for opening or closing the bridge is stated to be about half a minute. The pier consists of a caisson, reaching from low-water mark down to 45 ft. below that mark, or 17 ft. to 18 ft. into the clay. The caisson, with an outside diameter at the top of 43 ft. 6 ins., and at the bottom 45 ft., is to be built entirely of iron, with a double shell and a flooring placed 6 ft. 6 ins. above the cutting edge. The inner shell, with a thickness of ⅝ in., commences at the flooring and reaches up to within 2 ft. 9 ins. of the top of the coping of the pier, and forms the chamber inside which the buoy is placed. The outside shell of the caisson consists of plating 5-16 in. thick, stiffened by vertical and horizontal circular lattice girders, the latter being about 4 ft. apart. The floor is composed of ½-in. plates stiffened by two-plate girders, 4 ft. deep and 8 ft. apart, the cross girders being 18 ins. deep and 7 ft. 6 ins. apart, and tee-bars placed 3 ft. 6 ins. apart, the shell below the flooring being stiffened by brackets about 4 ft. apart. There are two shafts of 3 ft. diameter, giving access to the working chamber.

The annular pier, with a total-height of 35 ft. 6 ins. to the top of the coping, has an outside diameter of 40 ft. at the top and 41 ft. at the base. It is built of Portland cement concrete, and faced with granite, and has a thickness of 9 ft. 6 ins. at the base and 5 ft at the top. As previously mentioned, the pier, as well as the caisson, is lined with an inner shell of ⅝-in. plates, which are stiffened and held rigidly in position by light circular lattice girders bedded in the concrete. A chamber in the shape of an inverted truncated cone is thus formed inside the pier and the caisson. The huge buoy supporting the superstructure is floated in this chamber. The buoy consists of an outer shell ⅝ in. thick, and also has the shape of an inverted truncated cone, the lower portion being spherical, and the whole is stiffened by 12 vertical and a number of horizontal girders. The buoy is guided by a pivot at the lower end, and by 16 adjustable rollers at the upper end. These rollers bear against the lower part of a circular box girder placed on the top of the buoy.

A portion of the weight of the superstructure is transmitted to the buoy through this box girder. But the major portion of the weight is transmitted by direct thrust to the buoy from the center of the main girders through a number of diaphragms interposed between the underside of the main girders and the top of the box girders. The top of the buoy is covered by 5-16-in. plating supported by radial brackets. A large circular manhole is arranged at the center, from which suitable ladders and gangways are to be arranged, to enable inspection and painting to be easily carried out, and between the buoy and the inner shell of the pier a space of 2 ft. 6 ins. has been provided for this purpose.

To render the swing span when closed as steady as possible under the rolling load, the girders are allowed to rest on their bed-plates with a certain amount of pressure, so that every time the bridge has been swung the level of the water in which it is floating will have to be lowered. To reduce to a minimum the quantity of water required for this purpose, a string of movable boxes has been arranged near the top of the pier, leaving a space of 3 ins. between the boxes and the buoy. The buoy has a considerable amount of surplus buoyancy, but by ballasting the displacement might be regulated in such a manner that the level of water would not fall below the underside of the movable boxes when the bridge is closed and the girders let down on their bearings. As every foot of water at the top of the buoy represents a displacement of a volume of water equal in weight to about 16 tons, it follows that the girders may bear with a pressure of 20 tons on their bed-plates if the level of water has to be raised 2 ft. to lift the girders off their bearings previous to turning the bridge. It is evident that by making the boxes deeper the amount may be increased at pleasure. The designers propose that fresh water be used for these operations so as to reduce corrosion to a minimum. The town supply might be used with advantage by carrying a supply pipe under the fixed spans out to the abutment pier for the opening span. Under the opening span another supply pipe would be carried to a circular tank arranged on the top of the buoy. At convenient intervals this tank is filled by connect-



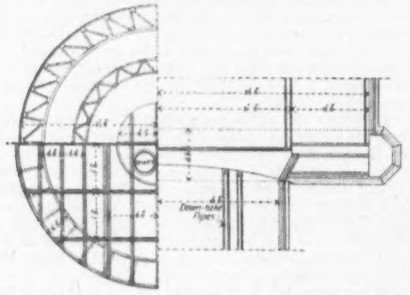
Pier and Buoy. Base of Pier.

PIVOT PIER OF THE PROPOSED DARLING HARBOR BRIDGE, SYDNEY, N. S. W.

ing the supply pipes at the abutment pier. As a rule they will be disconnected so as not to interfere with the opening and closing of the bridge. The circular tank is divided into four separate chambers, each connected by a pipe under the flooring, and provided with a valve. This will enable the tanks to be cleaned out and painted without interfering with the opening and closing of the bridge.

The inlet and outlet valves for floating and lowering the bridge will be worked from the roadway and arranged in duplicate. The turning gear consists of a rack and pinion, the former fixed to the channel bar forming the frame for the guide rollers, and can be operated by one man. The pinion would in most cases be worked direct; but if in case of exceptional conditions of wind, etc., this arrangement would not give sufficient power, a slow-motion gear might be provided in addition. Assuming that it would take half a minute to swing the bridge open, the skin friction would amount to about 40 lbs., and if the wind pressure be negligible, the two arms of the opening span being equal, the skin friction would be the only resistance to turning the bridge. The bridge may be swung in either direction.

The bed-plates under the two main girders have a projection 1 in. deep on each side of the girder, and the bed-plates under the ends of the girders have in addition a projection at right angles to the former, so that the girders when lowered on to their bed-plates are prevented from moving in either a lateral or longi-



Half-Sectional Plan of Pivot Pier and Draw-Rest, Darling Harbor Bridge.

tudinal direction. But in consequence of this it is necessary to lift the superstructure, say about 2 ins., before the bridge can be swung. An automatic signal is to be given when the structure has been lifted to the proper level, when the inlet valve will be closed. The pivot has been arranged so that the superstructure can be raised, say, 3 ins. or 4 ins., but in case of a breakdown of a valve or any other accident, the effect of which would be to raise the level of water inside the pier, provision has been made to prevent the buoy being lifted more than has been allowed for.

At each end of the opening span a barrier has been provided on the abutment piers. It consists of a light plate girder reaching across the roadway of the fixed portion of the bridge having a height of 3 ft. 6 ins. above the level of roadway. It fits into the end of a cast-iron parapet erected across the whole width of the footpaths, and is placed at the end of the fixed girders, so that it may be lowered and raised as the case may be through a slot in the roadway. An interlocking bolt, locking the movable girders, is to be arranged so that it cannot be drawn back and the swing span opened until the barriers have been raised. The two ends of the barriers are counterweighted so that one man may easily raise them. A shaft runs under the roadway from end to end of the barrier. This shaft, when being turned, communicates its movement by a couple of beveled wheels and a pinion at each end to the toothed racks fixed at the ends of the barrier, thus raising or lowering the same. The man turning the key actuates, in the first instance, the vertical shaft by a couple of beveled wheels. By another pair of such wheels this movement is communicated to the horizontal shaft. The top angles of the barrier when lowered rest on cast-iron beams, into which the angles are dished. The top of the barrier will thus be flush with, and has the same curvature as, the surface of the roadway.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

PENNSYLVANIA.—The total mileage of the Pennsylvania system at the end of 1892 was 7,979 miles, an increase of 733.96 miles over that of the previous year. Of this increase 109.24 miles were on the lines east of Pittsburg and Erie, and 24.72 miles were on the lines west of Pittsburg and Erie. The total trackage of the system is 14,278 miles, an increase of 601 miles.

PENNSYLVANIA.—This company has placed orders for 60,000 tons of steel rails, to be used in its new construction and improvements during the current year.

LEHIGH VALLEY.—The following new track was laid by this company on branches and extensions in 1892: Swartwood to Geneva, N. Y., 53.72 miles; West Shore crossing to Rochester, N. Y., 4.5 miles; Rochester Junc. to Honeoye Falls, N. Y., 23.75 miles; Bowman's Creek, Pa., to Harvey's Lake Branch Junc., 2 miles; Harvey's Lake to Bowman's Creek, Pa., 12 miles; Moss Creek to Thorndale, Pa., 1 miles, and extension of Perth Amboy & Raritan River R. R., in New Jersey, 4.5 miles.

KISHACOQUILLAS VALLEY.—Ch. Engr., F. F. Whittekin, Tionesta, Pa., informs us that work will be continued on the line from Reedsville to Belleville, Pa., 9.2 miles, 5.82 miles of which were completed in 1892. There is also some prospect of the Belleville, Greenwood & Western Ry., from Belleville to McAlevy's Fort, Pa., 15 miles, being put under construction.

TIONESTA VALLEY.—An official writes that about four miles of railway will probably be put under construction by this company during the present year.

LANCASTER & HAMDEN.—Gen. Man. E. P. Buell, Circleville, O., writes that this company will build the following lines this pear: Laurelville to Wellston, O., 40 mile; Locust Grove to Vinton Furnace, 16 miles; S. & M. V. Junc. to Columbus, O., 26 miles; Columbus to Defiance, 115 miles.

GRAND RIVER.—This company intends to put its proposed line from Grand Rapids to Belding, Mich., 35 miles, under construction this year, and also to complete its line from Grand Rapids to Grand Haven, 35 miles, 15 miles of which, from Jenison to Blindon, Mich., were completed in 1892. Secy., M. C. Dority, Grand Rapids, Mich.

WASHINGTON & CHESAPEAKE BEACH.—Secy. F. W. Tyrer, Washington, D. C., writes us that work will begin on this railway from Washington, D. C., to Chesapeake Beach, 28 miles, as soon as the frost is out of the ground.

BUFFALO, ROCHESTER & PITTSBURG.—An official writes us that the grading is nearly finished on the line from Jefferson Line, Pa., to Clearfield, Pa., 26¼ miles, and that track laying has been begun.

Projects and Surveys.

MEDFORD & MANAHAWKIN.—A project is on foot to build a railway from Medford to Manahawkin, N. J., 30 miles.

NORTHUMBERLAND, SCRANTON & BLOOMSBURG.—Organized in Pennsylvania to build a railway from Scranton to Northumberland, Pa., 80 miles.

NEW YORK & DANBURY.—The Danbury & State Line R. R. Co., of Connecticut, and the New York & Danbury R. R. Co., of New York, will be consolidated under the latter name. The route of the line from Danbury, Conn., to Goldensbridge, N. Y., where it will connect with the New York & Northern R. R., 14 miles, has been informally approved by the Connecticut State Railroad Commission.

PHILADELPHIA, HONESDALE & ALBANY.—Engineers are reported to be making surveys for a railway from White Haven, Pa., to Arkville, N. Y., 125 miles. It is stated that a large coal syndicate is backing the enterprise.

TOM'S RIVER & BARNEGAT.—Chartered in New Jersey to build a railway from Tom's River, N. J., to Barnegat, N. J. Among the incorporators are: J. K. Maxwell, Brooklyn, N. Y.; R. W. de Forest, New York, N. Y., and H. P. Baldwin, Roselle, N. J.

Southern.—Existing Roads.

JACKSONVILLE, ST. AUGUSTINE & INDIAN RIVER.—The contract is reported let for the proposed extension from Rockledge to Eau Gallie, Fla., 23 miles.

WINCHESTER & BEATTYVILLE.—This railway, which was built in 1892, from Beattyville, Ky., northeast to Beattyville Junc., on the Kentucky Union Ry., 5.6 miles, will probably be extended south from Beattyville to Boonville, Ky., it is stated.

Projects and Surveys.

PENSACOLA, ALABAMA & TENNESSEE.—It is stated that this company, which was organized some time ago, to build a railway from Pensacola, Fla., to Memphis, Tenn., has let the contract for 40 miles from Pensacola, Fla., north, to J. D. Halbert, of Baldwin Co., Ala.

HARRIMAN & NASHVILLE.—This company, recently incorporated in Tennessee, proposes to build a railway from Harriman to Nashville, Tenn. The incorporators are: W. T. Smith, W. C. Harriman, A. R. McKenzie, G. W. Pearsall and J. J. Stearns.

SEAVIEW CITY.—This company has applied to the South Carolina legislature for a charter to build a railway from Hog Island, in Charleston, S. C., Harbor, through Mt. Pleasant and Moultrieville, to the east side of Sullivan's Island. Chas. I. Rawson, J. T. Stoddard, E. L. Collins and others are interested.

CHICAGO, HARRIMAN & SOUTH ATLANTIC.—A preliminary survey has been completed for this railway from Harriman, Tenn., to Anderson, S. C.

POTOMAC & APPALACHIAN.—The surveys are making good progress on this railway from Cumberland, Md., to Petersburg and Franklin, W. Va. J. C. Bradford, Engr., Harrisonburg, Va.

NORTH CAROLINA.—A bill incorporating the Virginia & North Carolina R. R. Co. has been introduced into the state legislature.—The Neuse & Swansboro R. R. Co. will ask the state legislature for a charter to build a railway from Riverdale to Swansboro, N. C.—A bill is before the legislature incorporating a company to build a railway from Winston, N. C., to Charleston, S. C.

Northwest.—Existing Roads.

CHICAGO & NORTHWESTERN.—The surveys have been completed for the proposed line from Princeton to Necedah, Wis., and it is stated that the material for construction is being shipped.

MINNESOTA & WISCONSIN.—Work will begin as early as possible in the spring upon the extension from Emerald, Wis., north 16 miles.

Projects and Surveys.

ORTONVILLE & SOUTHERN.—This company has been reorganized and proposes to build a railway from the Iowa line in Nobles Co., Minn., southeast to Ortonville, Iowa. Among the incorporators are: Wm. Van Eps, Sioux Falls, Iowa; C. H. L. Lange, Ortonville, Iowa; T. M. Grant, Minneapolis, Minn., and J. H. Long, Slayton, Iowa.

Southwest.—Existing Roads.

LOUISIANA NICKEL PLATE.—Gen. Man. W. G. Wadley, Houghton, La., writes us that this company now has six miles of railway in operation and six miles more from Haynesville, La., north to near Belvue, La., surveyed. One mile of this has been partly graded, and three miles are to be built in 1893. The road is projected to run to the Arkansas boundary, and it is intended to build three or four miles each year.

KANSAS CITY, PITTSBURG & GULF.—This company has secured control of the Texarkana & Ft. Smith R. R., and will, it is stated, complete its proposed extension north.

Projects and Surveys.

TEXAS & GULF.—This company will soon be chartered to build a railway from Marshall, Tex., to Sabine Pass. Among the incorporators are: M. R. Geer, Marshall, Tex.; E. S. Hicks, Canton, Tex., and T. S. Garrison, Simpson, Tex.

MEMPHIS & JOPLIN.—It is hoped to begin the survey of this line, from Memphis, Tenn., to Joplin, Mo., soon, and to begin construction as soon as the surveys are completed and the right of way secured. J. A. Grayson, Pierce Co., Mo.

Rocky Mountain and Pacific.—Existing Roads.

CALIFORNIA & NEVADA.—Work is in progress upon an extension five miles east of Bryant Park, Cal. Grant Bros., of San Francisco, Cal., have the contract.

SHELTON SOUTHWESTERN.—This company will build an extension from Shelton to Summit, Wash., 6 miles, this season. Secy., Edwin E. Crowell, Shelton, Wash.

Projects and Surveys.

DENVER BELT LINE.—Chartered in Colorado to build a belt line transfer railway around the city of Denver, Colo. The projected lines will aggregate 50 miles in length. Among the incorporators are: Robt. Y. Force, Henry C. Brooks, H. L. Morris, of Denver, Colo.

SALT LAKE & NORTHEASTERN.—Chartered in Utah to build a railway from Salt Lake City, Utah, to Evanston, Wyo.

MONTANA SOUTHEASTERN.—Chartered in Montana to build a railway from a point near Butte; thence southeasterly up Black Tail Creek to the summit of the main range of the Rockies; thence easterly up the Little Pipestone and Fish creeks to the valley of the Jefferson River; thence up said valley and the valley of the Ruby River to the summit of the Rockies in Madison Co., with a branch to Bozeman from some point in the valley of the Jefferson River; also, from some convenient point on the main line southerly to Dillon, and up the valley of the Beaverhead River, and a branch from near the valley of the Ruby River, east to the valley of the Madison; thence up the Madison River and its tributaries to the summit of the main range on the southwest boundary of the state. The capital stock is $1,000,000. The principal office of the company is to be at Butte. The incoroprators are: Henry L. Frank, Lee Mantle, Charles S. Warren, Geo. W. Irvin, W. McWhite, and N. C. Ray, of Butte.

MONTEREY & FRESNO.—At a recent meeting of the stockholders of this company, which proposes to build a railway from Fresno to Monterey, Cal., the following officers were elected: Pres., A. W. Jones, Kansas City, Mo.; Vice-Pres., H. A. Green, Monterey, Cal.; Secy., L. W. Moultrie, Fresno, Cal., and Treas., T. C. White, Fresno, Cal.

ELECTRIC RAILWAYS.

CHATTANOOGA, TENN.—A company has been organized by Willard Warner, C. E. James, Franklin Harris and others to build an electric street railway.

DALLAS, TEX.—C. W. Childress and others have secured a franchise for building an electric street railway. It is stated that about 15 miles will be built by June 1, 1893.

SAN ANTONIO, TEX.—The Alamo Electric Street Railway Co. has secured a franchise to build 25 miles of electric railway.

HORSE AND MOTOR RAILWAYS.

BRIDGEPORT, PA.—Chartered, Montgomery Co. Passenger Ry. Co.; capital stock, $50,000; Pres., Cornelius Gallagher, New York, N. Y.

CHESTER, PA.—Chartered, Philadelphia & Delaware Ry. Co.; Philadelphia to Chester; capital stock, $150,000; Pres., John H. Hinkson.

DUNMORE, PA.—Chartered, Scranton Rapid Transit Co.; Scranton to Dunmore; capital stock, $60,000; Pres., P. J. Hovan.

FREELAND, PA.—Chartered, Union St. Ry. Co.; Drifton to Freeland; capital stock, $18,000; Pres., Harry E. Sweeney.

WISSIMONING, PA.—Chartered, Wissimoning, Bustleton & Somerton Ry. Co.; capital stock, $48,000; Pres., Geo. A. Castor, Holmesburg.

MIFFLINTOWN, PA.—Chartered, Lancaster & Philadelphia R. R. Co.; Lancaster to Philadedphia; capital stock, $1,500,000; Pres., John J. Patterson.

OLYPHANT, PA.—Chartered, Olyphant & Winton Traction Co.; Olyphant to Winton; capital stock, $36,000; Pres., Joseph A. Dalphin.

PHILADELPHIA, PA.—Chartered, Conshohocken Ry. Co.; Norristown to Conshohocken; capital stock, $100,000. Pres., Jas. W. Shepp.—Chartered, Radnor, Haverford & Philadelphia R. R. Co.; capital stock, $75,000; Pres., Frank S. Harriston.

LOWESDALE, PA.—Chartered, Holmesburg & Bristol Passenger Ry. Co.; capital stock, $60,000; Pres., Edward Morrell.—Chartered, Bristol & Trenton Passenger Ry. Co.; capital stock, $48,000; Pres., Edward Morrell.

SHENANDOAH, PA.—Chartered, Lakeside Ry. Co.; Mahanoy to East Mahanoy; capital stock, $50,000; Pres., John F. Finney.

HIGHWAYS.

PENNSYLVANIA.—The citizens of Abington will vote on the proposition to create a loan of $80,000, with which to macadamize the principal thoroughfares in the township.—The contract for an avenue, 6,000 ft. in length, connecting Wayne and Stafford, has been awarded to C. F. Stauffer, Wayne.

ARIZONA.—A wagon road is to be built by citizens of Nogales, from that place to Oro Blanco.

WYOMING.—The citizens of Sheridan are working for a wagon road across the Big Horn Mountains.

BRIDGES, TUNNELS AND CANALS.

DEWITT, MO.—The Brookfield & Northern R. R. Co. has completed the surveys for its proposed bridge across

the Missouri River, and will soon submit the plans to the Secretary of War. The bridge will be about 2,000 ft. long.

LINCOLN, NEB.—Bids will be received until Feb. 27 for constructing an iron and steel viaduct on O st. The estimated cost of the work is $130,000. L. E. Hicks, Chm. Brd. Pub. Wks.

ATLANTA, GA.—Bids will be received until April 1 for building a bridge to carry Alabama st. over the railway tracks of the East Tennessee, Virginia & Georgia R. R. Joseph Hirsch, Chn. Bridge Com.

WATER-WORKS.

New England.

RUMFORD FALLS, ME.—The Rumford Falls Light & Water-Works Co. has petitioned for authority to issue bonds and extend its works. A tank may be built. The plant was put in operation for domestic supply, Jan. 5, 1893.

YORK, ME.—The Agamenticus Water Co. has been organized. Pres., Frank Jones; Secy., M. A. Safford, Kittery; Treas., W. M. Safford, York. A capital stock of $100,000 is proposed, and a gravity supply from Folly Pond, 160 ft. above tide water.

ISLAND POND, VT.—It is said that works are to be built. A company now supplies water.

NEWBURYPORT, MASS.—It is reported that Engr. G. Norman Weaver has located a well for an increase to the supply, and that a 100×175-ft. reservoir will be built.

WEST SPRINGFIELD, MASS.—The people have instructed the town to take steps to obtain a water supply in accordance with a report by Engr. John Merrill. A pumping station is proposed.

CRANSTON, R. I.—A bill has been introduced in the legislature to incorporate the Cranston Water-Works Co. A supply is now obtained from the Providence works.

PROVIDENCE, R. I.—A committee has reported to the council in favor of a 15,000,000-gallon gravity mechanical filter plant; estimated cost, including buildings, $130,000.

Middle.

MARLBORO, N. Y.—Works are talked of.

MECHANICSVILLE, N. Y.—The water commissioners have been authorized to borrow $35,000 for the completion of the works.

SCHUYLERVILLE, N. Y.—The "Standard" urges that works be built.

WHITESBORO, N. Y.—A supply for fire protection is talked of. A small plant furnishes water for domestic uses.

JERSEY CITY, N. J.—Bids will be received by the Street and Water Board until Feb. 20 for a new supply as stated in detail under "Engineering News for the Week."

ALLENTOWN, PA.—An additional supply from Cedar Creek is proposed; estimated cost, $12,000 to $15,000.

GIRARDVILLE, PA.—A contract for a new dam has been awarded by the Girard Water Co. to M. P. Quinn and Lewis Grant; estimated cost, $75,000.

READING, PA.—G. H. Felix, Pres. Water Board, has recommended that a civil engineer be employed permanently in connection with the works, and that the use of meters be extended.

Southern.

PETERSBURG, VA.—Surveys will be made by the city engineer for a storage reservoir with a capacity of about 60,000,000 gallons. A pump may be added.

CULLMAN, ALA.—Legislation will probably be secured to permit the building of works.

North Central.

CLEVELAND, O.—Bids will be received until March 4 for four 4,500,000-gallon vertical pumps to take the place and be operated by the steam ends of the pumps now in use at the Front St. station. W. P. Tharp, Engr.

NAPOLEON, O.—Engr. J. B. Strawn, Salem, O., has been consulting with the officials regarding the building of water and electric lighting plants.

FAIRMONT, IND.—The people have voted 432 to 120 to build works.

LA GRANGE, IND.—It is said that $20,000 of bonds will be issued and works built.

BATTLE CREEK, MICH.—Supt. W. W. Brigden informs us that two miles of mains with valves and hydrants, and 100 meters may be added this year.

ELKHORN, WIS.—Works estimated to cost $20,000 to $30,000 may be built.

KENOSHA, WIS.—Cy. Engr. F. F. Foote informs us that several companies have made propositions to build works.

Northwestern.

DELL RAPIDS, S. DAK.—Works are proposed.

FREMONT, NEB.—Specifications for a 130,000-gallon stand-pipe have been ordered made.

MILLER, S. DAK.—It is said that improvements are necessary.

Southwestern.

EL PASO, TEX.—Sylvester Watts, representing the water company, has offered to introduce a new supply, as outlined in our last issue, and sell the present works to the city for $232,000. The council has voted to award the contract to Rhodes Bros., substantially in accordance with their bid, given last week.

EL RITO, N. M.—The El Rito Reservoir Co. has been incorporated to supply water for domestic and irrigation uses; $5,000.

DENVER, COLO.—There is talk of purchase by the city of the works of both companies.

PITKIN, COLO.—Water and electric lighting plants are under consideration.

Pacific.

SPOKANE, WASH.—Engr. C. B. Davis, Chicago, has been engaged to report on a new supply.

ST. HELEN'S, ORE.—A. H. Blakeslee, Jas. Dart and R. Cox constitute a committee to report on establishing works.

Canada.

FAIRVILLE, N. B.—A supply from St. John or some other source is under discussion. Robert Armstrong and Jeremiah Stout are interested.

ARTESIAN WELLS.

KIRKSVILLE, MO.—A company is being organized to bore a well.

IRRIGATION.

McCOOK, NEB.—It is said that a canal will be constructed by the Nebraska Water Co., and that Geo. Hocknell is interested.

TACOMA, WASH.—The Palouse Irrigation Co., which has headquarters here, is said to be preparing to complete a canal 104 miles long, with a supply from Rock Lake, Whitman Co., where a dam is proposed. It is said that "90 miles of the waterway have already been completed."

PERRIS, CAL.—The contract for supplying laterals for the Perris Irrigation District has been awarded to the Lacey Mfg. Co., Los Angeles, for $90,000.

YUMA, ARIZ.—A press dispatch states that a contract for the construction of the South Gila canal has just been let to Iriand & Vickry, of Los Angeles, Cal. It is said that the work when completed will cost $2,000,000, also, that the main canal will be 70 miles long, with an average flow of 6 ft. of water and will irrigate 160,000 acres of land.

NEW COMPANIES.—People's Reservoir Co., Fort Collins, Colo.; $100,000; C. H. Wheeler, A. A. Howard and others; J. B. Swan will have charge of construction. Chiquita Flume & Irrigation Ditch Co., Fresno, Cal.; $100,000; T. S. White, Grand Rapids, Mich., Jos. Hadden, Oakland, and others; a long flume is proposed.

SEWERS.

EVERETT, MASS.—The Board of Aldermen has voted to issue $125,000 additional sewer bonds.

LOWELL, MASS.—The question of sewage disposal without polluting the water of the Merrimac River is being urged. The citizens of Lawrence are especially interested, as the present outlet is but nine miles above the intake of the water supply of that city.

MEDFORD, MASS.—The Common Council is considering the petitioning of the Legislature for authority to construct and maintain a system of sewerage, and to enable the city to provide for the cost and expenses thereof.

PROVIDENCE, R. I.—The Commissioner of Public Works will receive bids until Feb. 14 for four brick sewers; size, 40 to 70 ins.; length, about 9,000 ft.

HERKIMER, N. Y.—O. H. Perry, J. H. Huyck, Dr. I. O. Nellis, C. E. Snyder, and A. C. Devendorf, have been appointed a commission to have charge of the construction of the proposed sewer system. The estimated cost of the system is $35,000, and the plans were prepared by F. K. Baxter, Utica, as noted in our issue of Dec. 15.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Feb. 20 for two contracts for sewer work.

CINCINNATI, O.—A contract for a sewer in Browne and Baymiller Sts. has been awarded to W. C. Dawson, at $14,987.

MANSFIELD, O.—Sewer District No. 4 will be completed during the coming summer. Jacob Laird, Cy. Engr.

ADRIAN, MICH.—We are informed that about 3,000 ft. of brick and tile sewers will probably be constructed soon.

HARLEM, ILL.—Plans for a sewer are being prepared by Robt. E. Williams, Oxford Bldg., Chicago.

SEATTLE, WASH.—The City Engineer reports that about 3 miles of sewers were constructed last year (the total length is now 18.5 miles) and that 50 miles of additional sewers should be constructed during the next three years. It will require at least $500,000, he says, to construct needed sewers in streets now improved and settled. The Lake Union sewer tunnel will be ready for use within a year, and the South sewer tunnel a few months later. The report calls attention to streets where sewers are most needed, and the estimated cost of sewers in these is $225,000.

STREETS.

HOLYOKE, MASS.—Bids will soon be asked for 10,000 ft. of curbing to be used during the year.

NEWTOWN, N. Y.—The Board of Supervisors of Queens Co. has granted the town authority to issue bonds for $47,000 to improve Flushing ave.

NEW YORK, N. Y.—The Commissioner of Street Improvements of Wards 23 and 24 will receive bids until Feb. 21 for five contracts for constructing crosswalks, paving with trapblocks, etc.

CONNELLSVILLE, PA.—We are informed by S. M. Froust, Cy. Engr., that the city has under consideration about ½ mile of brick paving. Last season ¼ mile of brick street and 1¼ miles of macadamized streets were constructed.

JENKINTOWN, PA.—The contract for telfording Beechwood ave., 2,554 ft. long and 30 ft. wide, was awarded to Chas. F. Stauffer, Wayne, at $5,809. The street is to have bluestone curbing and gutter paving.

ROANOKE, VA.—The city has sold street and sewer bonds for $95,000.

BEREA, O.—The village clerk will receive bids until March 6 for grading, draining, curbing with sandstone and paving with brick in Front St.

SPRINGFIELD, O.—The City Engineer has presented estimates for paving two streets with brick; total cost, about $16,000.

ELKHART, IND.—We are informed by Chas. L. Kinney, Cy. Engr., that the time for receiving bids for grading and paving with standard paving brick in two streets has been extended to Feb. 22.

OSHKOSH, WIS.—The Board of Public Works will receive bids until Feb. 20 for grading, curbing with stone, and paving with cedar blocks in six streets.

CANTON, ILL.—Bids will be received until Feb. 21 for eleven contracts for paving with brick, excavating, constructing stone curbing, etc.; aggregate of paving, about 50,000 sq. yds. J. C. Thompson, Jr., Cy. Clk.

DUBUQUE, IA.—We are informed by E. C. Blake, Cy. Engr., that the brick paving for the coming season will not be advertised until next month.

MARSHALLTOWN, IA.—We are informed by Wm. Bremner, Cy. Engr., that the city will probably pave with brick about 20,000 or 25,000 sq. yds. the coming season.

FRESNO, CAL.—The contracts for paving Fresno St. with bituminous rock has been awarded to the Pacific Paving Co., at $14,284, including concrete curbing. The contract for grading the street was awarded to S. W. Henry at $9,000.

ELECTRICAL.

FONDA, N. Y.—The question of putting in an electric plant is reported as being agitated with good promise of success.

KISSIMMEE, FLA.—It is reported that an electric light plant will be put in if the right of way can be secured.

MADISON, WIS.—The lowest bid for lighting the city for two years with electric lights was that of Schulkamp & Houseman. There were two other bids. This company sold its plant recently to the Thomson-Houston Co. for $51,000, when that company secured the contract for furnishing the electric railway power.

MOUNT OLIVE, ILL.—The village clerk will receive bids until Feb. 13 for putting in an electric light plant and supplying light to the village and citizens, on a franchise for five or ten years.

TOPEKA, KAN.—The Chicago-Topeka Light, Heat & Power Co. has been organized to build a dam near this city, and to construct a large electric plant, estimated to cost $300,000. J. T. Fanning, Minneapolis, Minn., has reported favorably on the matter of the dam, and the City Council is now considering the granting of a franchise. The company desires to maintain electrical and other works, air compressors and appurtenances, and to furnish and transmit electric light, heat and power for refrigerating and ventilating, and other purposes. The ordinance being considered also provides for the taking by the city of 600 HP. per year, at the rate of $40 per HP., for ten years from July 1, 1893, or as soon thereafter as the dam and plant are completed.

NEW COMPANIES.—Richter Electric Co., Camden, N. J.; $100,000; Chas. Richter, Camden; S. M. Brice, Philadelphia, Pa.; Chas. C. Reinhard, Riverton, N. J. Bound Brook Electric Light, Heat & Power Co., Bound Brook, N. J.; $5,000; C. P. Sebrig, North Plainfield, N. J.; L. J. Amerbacher, Newark, N. J.; F. H. Cook, Bound Brook. Wetumpka Falls Electric Power & Mfg. Co., Wetumpka, Ala.; $1,000,000; M. B. Houghton, F. M. Billing, H. S. Williams.

CONTRACT PRICES.

ASPHALT PAVING.—Detroit, Mich.—The lowest bids for paving three sections of Woodward Ave. with asphalt were those of O. E. C. Guelich, $2.785, $2.81 and $2.85 per sq. yd.; total, $146,030.

CEDAR BLOCK PAVING.—Detroit, Mich.—The contract for paving Waterloo St. with cedar blocks has been awarded to Geo. E. Currie, at $1.64 per sq. yd.

DREDGING.—Portsmouth, Va.—The following contracts for government work have been awarded: C. T. Caler, Norfolk, North River bar, 29 cts. per cu. yd.; North River, 13.5 cts.; Chickahominy River, 23 cts. Rittenhouse-Moore Dredging Co., Mobile, Ala., Nansemond River, 25 cts.

JETTY WORK.—Houston, Tex.—The following contracts have been awarded for the jetty at the foot of Ninth St.: R. H. Downey & Bros., cedar piles, 21 cts. per lin. ft.; Kerr, Wilson & Co., about 25,000 tons of 130-lb. stone, $2.13 per ton. But one bid was received for each of the following: F. A. Brock, 350 cords of brush, $5.90 per cord; A. H. McLean, 30,000 cu. yds. of bay sand, 68 cts. per cu. yd.

HARBOR IMPROVEMENT.—Philadelphia, Pa.—Bids for the dredging and improvement of the harbor, as described in our issue of Jan. 19, were opened by Major Raymond, U. S. Engineer Office, Jan. 31. The total bids were as follows: 1. Michael J. Coffey (Brooklyn, N. Y.), and M. J. Connelly (Quebec), $2,987,750; 2. American Dredging Co., $3,403,780; 3. Penn Dredging Co., $3,541,280. The detail prices were as follows:

Excav. and depositing 21,500,000 cu. yds.	1 12.5 cts.	2 14.2 cts.	3 14.7 cts.
Remov. pile and timber wharf, 16,200 lin ft.	$1.25	$1.90	$1.90
Depositing and spreading 2,000,000 cu. yds. on League Island	14 cts.	16 cts.	17½ cts.

RETAINING WALL.—Jenkintown, Pa.—A contract for 350 perches of retaining wall has been awarded to Chas. F. Stauffer, Wayne, at $4 per perch.

GRANITE PAVING BLOCKS.—Waltham, Mass.—The contract for 125,000 granite paving blocks has been awarded to the Quincy Paving & Edgestone Co., Quincy, $34.90 per M. The highest bid was $42.

SEWER GRATES, ETC.—Detroit, Mich.—The Board of Public Works has awarded the following contracts to the Griffin Car Wheel Co.: Sewer grates, $1.65 per 100 lbs.; round locking sewer grates, $4 each; round locking basin covers, $2 each; horse drinking fountains, $40 each.

SEWERS.—Indianapolis, Ind.—Contracts have been awarded for four of the main sewers recommended in the plans of Rudolph Hering: 1. Sewer in East Washington St., 3 to 5.5 ft. egg-shaped, length 8,312 ft., estimated to cost $9.62 per lin. ft.; lowest bid received when the work was advertised last fall was $8.54; contract awarded to Donald McLeod, Chas. Doe and John Deloyea, at $6.44. 2. Sewer in Alabama St., 2 ft. 2 ins. × 3 ft. 3 ins. length, 1,916 ft., estimate $3.63; contract awarded to Winslow, Bossert & Co., at $3.17. 3. Sewer in East St., 3 to 5 ft. circular, length 6,377 ft.; estimate, $7.33; contract awarded to W. R. Mercer at $6.24. 4. Sewer in Alabama St., 4 to 4.5 ft. circular, length 2,053 ft., estimate $7.50; contract awarded to McLeod, Doe & Deloyea at $5.45. The bids per lin. ft. were as follows:

	1.	2.	3.	4.
Aetna Construction Co.	$12.40	$6.60	$9.60	$8.90
Henry Van Arsdale	11.22	4.34	6.79	7.33
L. A. Fulmer & Co.	9.31	3.27	6.88	7.12
National Construction Co.	9.24	...	8.60	8.87
T. W. Kinser & Son	9.20	...	6.90	7.10
Jesse Robertson	9.00	...	...	...
Wilson & Straek	8.80	3.89	7.15	8.30
South Bend Con. Co.	6.54	...	6.35	...
McLeod, Doe & Deloyea	6.44	4.30	6.45	5.45
Gansberg & Roney	...	4.10	...	8.25
H. C. Roney	...	3.59	...	...
T. T. Sheehan	...	3.55	...	...
W. R. Mercer	...	...	6.24	...
A. Bruner	...	3.50	...	...
Winslow, Bossert & Co.	...	3.17	6.29	6.79

MISCELLANEOUS.

BROOKLYN BRIDGE STATION.—We are informed by Mr. G. Leverich that the contract for the new Brooklyn station of the New York & Brooklyn Bridge has been awarded to the Phoenix Bridge Co., at $225,127. The other bidders were Post & McCord, $229,312, and Milliken Bros., $244,955. Particulars of the work are given in another column.

LEVEE.—A levee or dike is proposed to be built along the Mississippi River bank in Madison Co. and St. Clair Co., Ill. Mr. Stephens, Mayor of East St. Louis, Ill., is interested.

JAILS—Madison, Wis.—Bids for the erection of a county jail and sheriff's residence will be received by the County Clerk at Madison, Feb. 28. Plans and specifications prepared by the Pauly Jail & Mfg. Co., St. Louis, Mo.

Selma, Ala.—Bids for a brick jail for 100 prisoners will be received until Feb. 15, by Josiah Smith. Ten steel cells for four prisoners each, hospital cells, offices, closets, room for executions, etc.

BREAKWATER—Buffalo, N. Y.—The contract for the extension of the breakwater has been awarded to the Donelly Contracting Co., of Oswego, N. Y. The work will cost about $100,000.

DRAINAGE CANAL—Chicago, Ill.—The contracts have been awarded for the excavation of the main drainage canal between Willow Springs and Summit, the bids for which were opened last week. Sections A and B, L. D. Conner & Co., Harvey, Ill.; $772,525 and $371,525, proposition No. 2. Section C, Western Dredging & Improvement Co., Lafayette, Ind., $445,066, prop. No. 2. Section E, Streeter & Kenefick, Kalamazoo, Mich., $504,455, prop. No. 1. The contracts already let are Section D, to E. D. Smith & Co., $479,867, and Section F, Ricker, Lee & Co., $366,800, making a total of $2,940,208 for the six miles of excavation between Summit and Willow Springs.

Proposition No. 1 requires that the spoil shall be removed from 600 to 1,200 ft. from the banks of the channel, while No. 2 permits its deposit at the convenience of the contractor. The former provides for the preservation of a clear space along the bank of the channel, which may become very valuable for dockage or manufacturing. The contract for dredging the Illinois & Michigan Canal, from Summit to Bridgeport, 1,800,000 cu. yds., has been awarded to O. B. Green, Chicago, at $368,300, under proposition No. 2.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works have on hand orders for 100 engines for the Baltimore & Ohio, 18 eight-wheel passenger engines and 2 six-wheel switching engines for the Long Island, and 10 ten-wheel engines for the Monterey & Mexican Gulf. The Grant Locomotive Works, Chicago, Ill., are building 30 freight engines for the Chicago, Burlington & Quincy, and 25 freight engines for the Burlington & Missouri River. The Schenectady Locomotive Works, Schenectady, N. Y., have an order for 50 engines for the Chicago & Northwestern. The Pennsylvania is building at its Alton shops 18 engines for its southwest lines. The Great Northern will add 40 mogul engines and 10 ten-wheel engines to its equipment.

CARS.—The Ohio Falls Car Co., Jeffersonville, Ind., has an order for 30 baggage cars 60 ft. long, on six-wheel trucks. The Middletown Car Works, Middletown, Pa., are building 300 cars for the Burton Stock Car Co. The Northern Pacific is building 100 flat cars at its shops at Tacoma, Wash.; they are 40 ft. long, intended for carrying bridge timbers. The Pennsylvania will add 2,000 freight cars to its equipment. The Basic City Car Works, Basic City, Va., have an order for freight cars for the Chesapeake & Ohio. The Barney & Smith Car Co., Dayton, O., is building 10 passenger cars, with Barr vestibules, for the Chesapeake & Ohio.

CAR WORKS.—The Gilbert Car Works, Troy, N. Y., will be enlarged by the building of an addition of 90 ft. to the new shops. The contract for building the Great Northern Ry. car shops at Spokane, Wash., has been let for $80,000. There will be a foundry and machine shop, 150×160 ft.; roundhouse, with 20 stalls; car repair shop, 300×90 ft.; paint shop, 152×55 ft., and a sand and oil house, 100×40 ft.; the total cost, including machinery, will be about $140,000. It is reported that Mr. Isaac Witz, President of the Basic City Car Works Co., Basic City, Va., has effected arrangements with the American Car Co., through its President, Mr. C. D. Pettis, of Chattanooga, Tenn., by which the extensive plant will be operated at once; Mr. Pettis is now at Basic employing hands and completing arrangements for the manufacture of cars. The plant is equipped with improved machinery, and will turn out seven freight cars per day. Contracts have already been signed for the building of a large number of cars for the Chesapeake & Ohio. The Erie Car Works (Limited), Erie, Pa., representing $500,000 investment, is reported to have failed and been seized by the sheriff upon executions amounting to $102,000 in favor of Erie banks. The plant covers ten acres of land, and comprises car works and car wheel works; also a large furnace at Point St., Ignace, Mich. The works had a large contract for cars for the Pennsylvania.

SUPPLIES.—Angier & Kennard, formerly of Boston, have opened an office in the Monadnock Building, Chicago, to act as selling agents for a general line of electrical, mill and other railway supplies. They represent the Butler Hard Rubber Co., New York Rubber Co. and F. H. Lovell & Co., all of New York city.

BUILDINGS.—Corydon T. Purdy, Rookery Building, Chicago, is consulting engineer for the ironwork on the following new buildings: Katahdin, Wachusetts and Old Colony, each 17 stories; Ellsworth and Boyce, 12 stories each, all in Chicago. Also for the Puritan Realty Co.'s building, St. Louis, Mo., 10 stories; Spitzen Building, Toledo, O., 10 stories, and is completing the Lee, 10 stories, and Columbus, 14 stories, both in Chicago.

THE AMERICAN ROAD MACHINE CO., Kennett Square, Pa., reports a growing demand for its rock crushers. A 7% dividend was declared at the recent annual meeting.

NEW COMPANIES.—National Sewer Pipe Co., Barberton, O.; capital stock increased to $1,000,000 for enlargement of plant. Straight Line Meter Co., Syracuse, N. Y.; $40,000; Pres., C. M. Warner; Secy., Wm. D. Hawley. Piedmont Paving Co., Oakland, Cal.; $60,000; C. D. Bates, W. J. Dingee and W. W. Jacobs. Portland Construction Co., Jersey City, N. J.; $12,000, all paid up; H. K. Adams and Richard Lyne, of New York, N. Y., and George W. Dolly, Woodbridge, N. J. Union Railway Construction Co., Chicago, Ill.; $100,000; O. J. Petterson, George F. Wightman and B. F. Richolson. Clements Bros.' Construction Co., Cleveland, O.; $1,000,000; Robert J. Clements, Charles H. Lewis and Henry Boyer. Ironton Cross Tie Co., Ironton, O.; $50,000; to deal in cross ties and bridge timber; C. C. Clarke, D. L. Ogg and M. Halloran.

CURRENT PRICE LIST.

RAILS.—New York: $29 at eastern mills and at tidewater; girder rails, $35 to $36; old rails, $17 for iron, and $14 to $15 for steel. Pittsburg: $29; old rails, $20 for iron and $15.75 for steel. Chicago: $30 to $30 for standard sections; old rails, $18.50 to $18.75 for iron and $11.50 to $13 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.65 to 1.75 cts. for iron and steel; spikes, 2 to 2.05 cts. at mill; track bolts, 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 55% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10% on black and galvanized lap welded. Casing, 57½%.

FOUNDRY PIG IRON.—New York: $13.25 to $15. Pittsburg: $12 to $14. Chicago: $13 to $14.25.

LEAD.—New York: 3.85 to 3.9 cts.; Chicago: 3.65 to 3.7 cts.; St. Louis, 3.65 cts.

STRUCTURAL MATERIAL.—New York: beams, 1.95 to 2.25 cts. for large lots, and 2.25 to 2.75 cts. for small lots; channels, 2.1 to 2.2 cts.; angles, 1.85 to 2 cts.; tees, 2.1 to 2.3 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.85 to 2 cts. for tank, 2.1 to 2.25 cts. for shell, 2.4 to 2.65 cts. for flange, 2.6 to 2.8 cts. for firebox. Pittsburg: beams, 1.9 to 1.95 cts.; channels, 1.9 to 1.95 cts. angles, 1.7 to 1.75 cts.; tees, 2.05 to 2.15 cts.; Z bars, 1.9 cts.; universal mill plates, 1.7 to 1.75 cts.; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.7 to 1.75 cts. for tank, 1.95 to 2 cts. for shell, 2.05 to 2.1 cts. for flange, 3.4 to 3.5 cts. for firebox, 1.9 to 2 cts. for bridge. Chicago: beams, 2 to 2.25 cts.; channels, 2.27 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.2 to 2.3 cts.; sheared plates, 1.9 to 1.95 cts.; universal plates, 1.9 to 2 cts.; steel plates (at mill), 1.9 to 2 cts. for tank, 2.12 to 2.25 cts. for shell, 2.27 to 2.3 cts. for flange, 2.7 to 2.8 cts. for firebox.

NOTICE TO WATER-WORKS CONTRACTORS.

Sealed proposals will be received by the Board of Trustees, Winnetka, Ill., until 12 o'clock noon, Saturday, Feb. 18, 1893, to furnish all labor and material required in the construction of a water-works plant in accordance with plans and specifications for same on file with the Village Clerk, or address W. S. MacHarg, C. E., Commerce Building, Chicago.

A certified check of $1,000 required.

The Board reserves the right to reject any or all bids. C. W. TOSTEVIN,

6-1t Village Clerk.

U. S. ENGINEER OFFICE, NEWPORT, R. I., January 28th, 1893.—To whom it may concern: Whereas navigation is obstructed and endangered by the wreck of the schooner "Charlotte Fish," lying in Nantucket Sound, Mass., about 4 miles south of Monomoy Light House: Notice is hereby given that it will be removed by the United States under authority of law. Sealed proposals, in triplicate, for the removal of said wreck, will be received at this office until 12:30 p. m., on 8th day of March, 1893, and then opened. The attention of bidders is invited to the Act of Congress, approved August 1, 1892, Sections 1 and 2 (Public No. 193). Full information furnished on application. By authority of the Secretary of War. W. H. BIXBY, Captain, Corps of Engineers, U. S. Army. 6-4t

Have you ever tried the "Extensible Sewer Brace"? See advertisement of the Dunn Mfg Co. on Page ix.

U. S. ENGINEER OFFICE, 537 CONgress Street, Portland, Maine, January 27, 1893.—Sealed proposals for dredging in Cocheco River, N. H., will be received at this office until 3 p. m., Monday, February 20, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. PETER C. HAINS, Lieut.-Colonel of Engineers. 6-2t

U. S. ENGINEER OFFICE, 537 CONgress St., Portland, Maine, January 21, 1893.—Sealed proposals for dredging in Little Harbor, N. H., will be received at this office until 3 p. m. Monday, February 13, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. PETER C. HAINS, Lieut. Colonel of Engineers. 5-2t

U. S. ENGINEER OFFICE, ROOM H., 7, Army Building, 39 Whitehall Street, New York City, January 28, 1893.—Sealed proposals for dredging in the harbor at Clinton, Connecticut, will be received at this office until twelve (12) o'clock, noon, on Tuesday, February 28, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. D. C. HOUSTON, Colonel, Corps of Engineers. 5-4t

UNITED STATES ENGINEER OFFICE, Savannah, Ga., January 17, 1893.—Sealed proposals for dredging in Brunswick Harbor, Georgia, will be received at this office until 12 m., city time, on the 18th day of February, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. O. M. CARTER, Capt., Corps of Engineers, U. S. A. 5-2t

CITY HALL, PATERSON, N. J.

Sealed proposals will be received at this office until noon of Wednesday, March 1st, 1893, and then opened,—for furnishing materials and doing labor, for the proposed city hall, Paterson, N. J., in accordance with drawings and specifications, copies of which may be seen at the offices of the Commission, and at the offices of the architects, Carrere & Hastings, 44 & 46 Broadway, New York City, on and after Monday, February 13th, 1893.

Each bid must be accompanied by a certified check to the amount of 1% of the bid. The right is reserved to reject any and all bids, and to waive any defect or informality in any bid, should it be deemed in the interest of the municipality so to do.

Should any bidder desire a set of plans and specifications they will be forwarded by the Secretary on the receipt of $15.

Proposals must be on form procured either from the City Hall Commission, or from the architects; inclosed in sealed envelopes, and addressed to the Secretary, and indorsed, "Proposals for City Hall, Section No. ..., Paterson, N. J."

WALTER BEVERIDGE, Secretary, Room 12, Paterson Savings Institution, cor. Main and Market Sts., Paterson, N. J. 6-3t

TO PAVING CONTRACTORS.

Sealed proposals will be received by the Committee on Highways of City of York, Pa., until 12 m., Feb. 21, 1893, for furnishing all labor, material and implements necessary for paving four separate squares (approximately 10,000 sq. yds.) with asphalt blocks on 6-in. concrete foundation.

Plans and specifications can be seen at office of City Engineer, No. 6 West Market St., York, Pa.

Each bid must be accompanied by a sample of the block to be used, and also by a certified check of $500, drawn to the order of the City Treasurer of York, Pa., said $500 to be forfeited to City of York by bidder awarded the contract in case he should fail to enter into contract within ten days after awarding.

The right is hereby reserved to reject any or all bids.

Bids are to be marked "Proposals for Paving," and addressed to A. L. Boeckel, Clerk of Highway Committee, No. 353 S. Queen St., York, Pa.

By order of W. H. RUBY, Chairman.

Attest:
A. L. BOECKEL, Clerk. 6-2t

U. S. ENGINEER OFFICE, BURLINGton, Vt., February 7, 1893.—Sealed proposals for blasting and removing 2,000 cu. yds., more or less, of slate rock from a ledge near the State Reform School Dock, in Otter Creek, Vt., will be received at this office until 11 a. m., March 9, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. SMITH S. LEACH, Captain, Corps of Engineers. 6-2t 9-1t

Good Roads and how to secure them. See the advertisement of Carpenter Bros. on Page ix.

TREASURY DEPARTMENT, OFFICE Supervising Architect, Washington, D. C., January 28th, 1893.—Sealed proposals will be received at this office until 2 o'clock p. m., on the 17th day of February, 1893, and opened immediately thereafter, for all the labor and materials required for the cut stone and brick work, iron and wood floor, ceiling and roof construction and roof covering for the superstructure of the U. S. Post Office Building, at Cedar Rapids, Iowa, in accordance with the drawings and specification, copies of which may be had on application at this office or the office of the Superintendent at Cedar Rapids, Iowa. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any and all bids, and to waive any defect or informality in any bid if it be deemed in the interest of the government to do so. All proposals received after the time stated will be returned to the bidders. Proposals must be inclosed in envelopes, sealed and marked, "Proposal for Cut Stone Work and Brick Work, Iron and Wood Floor, Ceiling and Roof Construction and Roof Covering for the Superstructure of the U. S. Post Office Building, at Cedar Rapids, Iowa," and addressed to W. J. EDBROOKE, Supervising Architect. 5-2t